1984-85 Regional Tillage Conferences

University of Illinois at Urbana-Champaign
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Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, WILLIAM R. OSCHWALD, Director, Cooperative Extension Service, University of Illinois at Urbana-Champaign.

The Conference Speakers

Don Griffith has been a research and Extension agronomist at Purdue University since 1958. Griffith has been involved in tillage research since 1967, and presently he is the coordinator of research at regional agriculture centers in Indiana. Prior to his work at Purdue, he worked two years as an agronomist with McNeill and Libby.

William "Bill" C. Hintz started farming 410 acres of row crops with his father in 1951. Today, he farms 1,085 acres with his father, son, and two sons-in-law. They also have a short-line implement business.

Robert G. Hoeft is a professor of soil fertility Extension at the University of Illinois. His Extension programs deal with maximizing crop production through proper fertilizer use. He also is involved in research programs that are designed to identify factors that influence nitrogen loss potential and soil conditions that influence nutrient availability. Hoeft has been on the U of I staff since 1973.

Rich Johnson has been a senior scientist with John Deere and Company since 1980. As an agronomist, his key responsibility is to keep on top of changing technology in crop production. Prior to his work with John Deere, Johnson was an associate professor of agronomy with the University of Illinois for six and one-half years.

Ellery Knake has been a professor of weed science at the University of Illinois since 1960. Among his honors are the Paul A. Funk Award for outstanding work in the U of I College of Agriculture; the USDA Superior Service Award; and the GEIGY Award for outstanding contributions to agriculture.

Jim Krejci is a University of Illinois area Extension adviser with responsibility in resource conservation and management for southern Illinois. Presently, he is cooperating with the Soil Conservation Service on an eight-county project at the Mt. Vernon Hills Target Area--an area where soil erosion is accelerating.

George McKibben, a retired Extension crop production specialist at the Dixon Springs Agricultural Center, is widely recognized as one of the early developers of the no-till concept. In 1962, No-Till Farmer magazine named him "No-till Educator of the Year"; and in 1976, he received the Paul A. Funk Award for outstanding work in the U of I College of Agriculture.

Daniel Stadtmueller is a farmer with Foxfire Grain Farms, Limited, in Monticello, Iowa, and is current director of the National Corn Growers Association. He has also served as director and president of the Iowa Corn Growers Association; president and voting delegate of the Jones County Farm Bureau; director and president of the Northeast Iowa Research Farm in Nashua, Iowa; and first chairman of the Jones County Untillage Committee.

Kevin Steffey is an associate professor of agricultural entomology and an Extension entomologist at the University of Illinois. He joined the staff in 1979, and his duties include educational programs and applied research on insect pests in field crops. He also is responsible for the development of 4-H programs in entomology and integrated pest management.

Robert D. Walker has been the University of Illinois Extension natural resources specialist since 1960. Before that, he was an assistant Extension adviser in White County and an Extension adviser in Edwards County. In 1981, he received the fellow award from the Soil Conservation Society of America; and in 1983, he received the Natural Resource Extension Education award from the Federal Cartridge Corporation.

My Experience With Till-Planting

By Bill Hintz
Farmer from Monticello, Iowa
(Presented at the northern regional conference.)

In 1965, Doanes Digest was a slick-paper, monthly magazine that had feature articles much like Furrow Magazine today. One of the articles compared different types of tillage and had cost comparisons. In the margins of that magazine, I did my own homework; and according to my cost figures, I would be saving approximately $6.50 per acre by till-planting (ridge planting).

In the spring of 1966, the magazine came out with another feature article entitled "Till-Planting Leads the Field," and again they had cost comparisons with no-till and some of the other methods that were just being introduced. The last paragraph in this article said that Fleischer Manufacturing was making this equipment and that they had been selling out all of their equipment every year. At this point, I still had not seen a till-planter. I didn't know any more about this system than what I had read in the magazine.

In the fall of that year, we had a national corn picking contest in the Cedar Rapids area, and I planned to stay home. My father went, however, and when he came home to tell me he had found the best-looking cultivator he had ever seen, I started asking a lot of questions. He told me that it was yellow, but he couldn't remember the name. I remembered reading about Buffalo cultivators in that Doanes' article, so the next day I went to the corn-picking contest with the intention of looking up this implement company.

After visiting with the company representative, he stopped by my place the following day, and we talked about the system and how it worked. He gave me the names of six people who were using the system. They all lived 100 miles or more from my home, but I contacted these people either in person or by phone. Their responses were unanimous; they all liked what they were doing.

About that time, I also received a University of Nebraska bulletin entitled, "The Nebraska Till-Plant System." It was printed in 1961, believe it or not, and it had yield comparisons, as well as figures showing that there were savings in the costs of labor, time, machinery, and soil erosion. I was short of money at the time, but I ordered the planter anyway. I remember thinking it was a terrible price for that planter, but it turned out to be the best machinery purchase I have ever made.

During the winter, I started thinking about what I was going to do about weed control, and I decided to buy the cultivator. A few months later, though, I started to have second thoughts and wondered if I was doing the right thing and if I was going to survive the economic crunch we were going through at the time.

I said to my dad one day, "Maybe we ought to plow half of it this year and till-plant the other half just in case this thing doesn't pan out the way we think it should." He gave me some very good advice. He said, "You spent a lot of time checking this out; you were convinced it's going to work; you've invested a lot of money in it. I think you ought to just go ahead and till-plant everything." So we went ahead and till-planted 410 acres that first year.

This brings me to my first point. I know that you will receive a lot of free advice from people -- advice such as, "You ought to try 5 acres, 10 acres, a little this year and a little next year. You ought to try it in soybean stubble this year and cornstalk five years from now. Then try planting soybeans into cornstalks." I disagree with this advice. First of all, when you approach a new system in this manner over a long time, you don't exert the management that you ought to and you don't give the system the time and planning that is necessary for success. This is a self-defeating approach.

Before I go any further, I'd like to define what I mean when I use certain terms. When I talk about conventional tillage, I'm talking about moldboard plowing, disking, chiseling, and the various combinations that go with this type of corn planting. When I talk about no-till, I'm talking about a concept that is patented by Allis Chalmers. The original idea was to use a fluted coulter to cut stalks ahead of disk openers and to use chemicals in place of cultivation for 100 percent of the weed control. Another term that is used and means the same thing as no-till is slot-planting. This is a term that Fleischer Manufacturing uses with Buffalo Farm Equipment. Slot-planting is a bit more specific than no-till because when you slot-plant you work up an area that is only 1 to 2 inches wide, and once again you depend on chemicals for most of your weed control.

Till-planting was a planting concept developed at the University of Nebraska in the late 1950s. To sell their version of the till-plant system, people have come up with new and different names such as "strip tillage" and "ridge planting," but the concept is the same. I can show you an Extension bulletin that tells exactly how to go about till-planting. Basically, four steps were developed back in 1961. The first step is to shred the cornstalks; the second step is to do your planting; the third step is to cultivate; and the fourth step is to harvest.

Of the methods mentioned, I prefer till-planting for many reasons. In the yield data research that has been done at Purdue University, till-planting yields equal conventional

tillage yields in Wisconsin, Minnesota, Nebraska, Iowa, and northern Illinois. It out-yields disking and chiseling and far exceeds slot-planting in these states and the northern areas. Farther south in Missouri, Kentucky, Tennessee, Virginia, and Ohio, yield results have shown slot-planting to be superior to conventional planting by 10 bushels per acre.

Cultivation is another advantage of till-planting. I enjoy cultivating because it gives me a chance to compare corn varieties in the field. I can check on weed pressure to discover where the weed problems are, and I can control volunteer corn, as well as certain types of weeds that are hard to control with herbicides. I also get to check on the corn to see whether there is an insect or disease problem developing. I can make judgments on seedling vigor and stand, and I am better able to assess the crop by riding than by walking. Cultivating moves bulk spread fertilizer closer to the corn plant and helps in the decomposition that takes place in the row area. It forms ridges, which make the ground higher, drier, and warmer to plant on in the spring.

In addition, the planter works better when sweeping off a ridge and moving the residue into a depression than it does when planting in a depression and pushing the residue uphill or planting on a level field. This year, we put on 28 percent nitrogen with the cultivator, and I'm really excited about the results. Another advantage to forming ridges is that by throwing dirt up around your corn plant, you tend to get the brace roots out at a higher node and it encourages more root proliferation. That serves two purposes. If you have rootworms feeding, the damaged roots can be replaced by new growth; and by getting the soil up higher, you have the possibility of stronger bracing in case of a windstorm.

Another advantage of till-planting over conventional planting is that your corn plants generally don't grow as tall when planted in firm ground. (I say "generally" with tongue in cheek, because someone will go home and say that it will happen every time; but it won't happen every time necessarily.) We have a similar example with oats. An oat crop planted in a plowed field will grow taller than one planted in a disked field.

When I talk about ridge planting and building ridges with cultivation, I want to make a little clarification. In the literature that Buffalo puts out, they talk about 9- to 10-inch ridges; when going into Minnesota, they talk about huge ridges up to 12 inches; and in central Iowa, 9-inch ridges are popular. The ridges that I am talking about are approximately 5 inches high. They are no higher than the ridges that you can make with conventional tillage. The size of the ridge that you make is a management decision, and I think it should be made according to your situation. If you have plenty of natural drainage and you never have a problem with ponding, then I don't think you need as big a ridge. If you live in an area with a soil type where you have ponding, then a bigger ridge is desirable. It's one of those situations where you have to be careful of generalizations.

I mentioned earlier that ridges made by cultivation will be higher, drier, and warmer in the spring. Most of those who have a grain dryer understand how grain is dried and that the temperature is an indication of moisture content. Wetness and cold go together; dryness and heat go together. It's a real easy example to take a match to a wet towel and try to burn a hole through it -- you can't do it. But if you dry it out, you can burn a hole through it very rapidly. For those of you who have swales in your fields that fill up with water in the spring when it rains, you will reduce those pond areas considerably. The reason? By planting on the ridge you will have corn plants growing above the water level.

At some of the shows that I've attended, I've had people come up and tell me that the local soil conservation people are telling them not to till-plant on hills because they are going to get a lot of erosion. Whether or not you have erosion depends not so much on whether you till-plant, but on whether you contour plant around the hills rather than plant up and down them and whether you have left residue between the rows to slow down the runoff. Good management requires you to use all of the knowledge available to control erosion.

We know that the typical potential reduction in soil loss for terracing is 50 percent; for contour farming, 50 percent; for terracing and contouring combined, 75 percent; and for conservation tillage, 90 percent.* So where do you start? I would start with changes in tillage practices; and as the terrain got steeper, I'd include contours, which would put me at the 95 percent level. As the land became steeper, I'd terrace and have a 97.5 percent reduction in soil loss. In no case would I plant up and down hill on more than a 6-percent slope. I would till-plant on the leveler ground and slot-plant the steeper land. (see Tables 1 and 2).

Table 1. Typical potential reduction in soil losses.

Terracing	50%
Contour farming	50%
Terracing and contour farming	75%
Conservation tillage practices	90%
All combined	97.5%

From University of Nebraska-Lincoln, Bulletin #EC 76-714

*The soil loss reduction will vary from 40 to 90 percent, depending on the type of conservation tillage system used and the amount of residue left on the soil surface.

Table 2. Amount of residue retained by tillage operations.

Machines	Percent of residue retained
Moldboard plow	0
One way	60
Disk	
Tandem 1"	
18-22 inch disks	60
24-26 inch disks	50
Offset	
18-22 inch disks	60
24-26 inch disks	50
Chisel plow	75
Mulch treader	75-80
Sweep, 30-inch or larger	90
Rodweeder	90-95
Slot planter	100
Till planter, 3 inches deep on ridge	80

From University of Nebraska-Lincoln, Bulletin #EC 76-714

Ridges that are laid out properly have a depression between the rows; and it's in this depressed area that the cornstalk material congregates. In the row area, your corn stubs are still attached in the ground. When you plant, don't set your planter to take off the whole ridge. Skelp off only 1/2 to 1 inch of soil from the top. The soil will be moved into the middle area with the cornstalk material, leaving a slight plateau of firm ground where the corn row was planted last year. When you get a heavy rain, the water tends to collect between the rows where all of the stalk material is located. But when you have a heavy mulch of cornstalk material, it tends to absorb the rain and slow down the runoff so that more water soaks in. That way, there is less washing and ditch-cutting. The way that you cause erosion is by planting in the low places so water will collect there and run.

Now let's talk a little bit about the cost of till-planting. We all tend to be in a bind over high interest rates and overhead costs. I mentioned earlier that in 1966, till-planting saved me $6.50 per acre. Today, I figure it costs about $30 an acre more for conventional tillage than till-planting.

You may have seen the article in Successful Farming magazine a while back, which was written about Duane Murken -- our consultant for the Cedar Valley Farm Business Association. Those who are members of the Association all keep the same record-keeping systems, which are sent to the University of Iowa and run through a computer. The computer averages and compares sections of the state and the state as a whole. The records are accurate because they are used for tax preparation. Duane chose 10 members that practice

no-till or till-planting and compared them with members who used conventional tillage. He found that the no-till people spent more money for inputs such as fertilizer and herbicide; but over a three-year period, they averaged $24 per acre more profit than the conventional tillage people because they consistently had higher yields. This year, they compiled data showing that from 1974 through 1983, cash income was up 162 percent; cash expenses were up 200 percent; interest payments were up 449 percent; depreciation expenses increased 220 percent; and machine and power costs increased 179 percent. The Association's management return in 1974 was almost $20,000. But in 1983, it was a minus $18,582; in 1982, it was a minus $32,513; and in 1981, it was a minus $44,757. These figures ought to scare anybody in the farming business (see Table 3).

For some of you it is already too late, but for others you still have time to get your house in order. The sight of big black tires is a real ego trip for some, but it's not near as much fun as ending the year with a healthy profit. A grain farmer who has 640 acres can go into till-planting with only a six-row 30-inch planter, a six row 30-inch cultivator, and a tractor. You can get a new tractor for $35,000, a new planter for $15,000, and a new cultivator for $7,000, which is a total investment of only $57,000. You can get a good used tractor for $13,000 or less and a good used planter and cultivator for about $5,000 apiece. So, for an investment of $23,000, you can get equipment that will probably last five years with very minimal upkeep. And it could last a lot longer, provided you grease up your equipment and take care of it in the off season. Also, with till-planting, it shouldn't take you more than 75 working days to farm about 640 acres.

When it comes to harvesting, what should you do about combines? Well, it depends on the number of acres you have; but for me, I figure that in terms of cost, 640 acres is the breakeven point for whether I hire a combine or buy my own. With fewer acres, it is cheaper to hire the work done; and with more acres, it is cheaper to own a combine. As I mentioned before, my savings today are about $30 an acre. And $30 multiplied by 640 acres comes to $19,200. I don't know what the answer is for each and every one of you, but I think you need to do some serious thinking about reducing your grain-farming expenses.

I have given you a lot of the advantages of till-planting, but the main reason that I went into till-planting had to do with time and labor savings. In 1964, I was a full-time farmer. I had about 150 stock cows and farrowed between 75 and 100 litters of hogs in June. I fed out the calves each year, and my hogs were a farrow to finish on pasture operation. I was busy year-round, and when planting season came I was overloaded. I always had to hire some part-time help to plow and do tractor work. In May of 1964, I was put in the hospital for 23 days with rheumatic fever, and for six months I couldn't do anything but lay

around. At that time, I didn't know if I would ever farm again. I thank God for the way that He healed me and that I haven't had any noticeable affects since; but I still had too much work to do and too many high-pressure times in the spring. That is what prompted me to go into till-planting.

Today, we farm 1,086 acres of row crops. About 650 acres of that is in Monticello, Iowa, and the other 435 is in Davis County near Bloomfield, which is 15 miles from the Missouri border. In Monticello, we run continuous corn; and in Bloomfield, we raise both corn and beans. The two operations are 165 miles apart, so we would never be able to farm this far from home with conventional tillage.

The till-plant system was designed to start by shredding your cornstalks; however, that is one step that we have eliminated. I haven't shredded cornstalks for many years, and I haven't shredded very many. If you are just starting to till-plant, shredding the cornstalks may make it an easier adjustment. There are cornheads available, particularly the International cornhead, that have rolls running point to point and that do an excellent job chopping up the cornstalks. It is wise to have a chopper on the back of your combine because if you dump a row of cornfodder out the back of the combine, you will have a problem with bunching. The same thing goes for soybean straw.

In the fall, we usually put on whatever phosphate and potash we deem necessary. We bulk spread either liquid or dry and don't do anything else until the 15th of April. If it is warm and dry enough, the 15th is my target date to begin planting. (For 15 years, I had the 25th of April as a target date, but recently I have moved this date up.) This past year, I used 6-18-6 starter fertilizer at a rate of 140 pounds per acre. We started planting on the 18th of April, and on the 22nd we had 5 to 6 inches of fresh snow on top of the corn we had planted. We finished planting in Monticello on May 2; and then, right after planting, I had the corn sprayed with 100 units of 28 percent nitrogen and herbicides (1.2 gallons of Bicep for the corn, and Lasso and Sencor for the beans).

I know from experience that we have a limited length of time to cultivate between June 15 and 30. I have two six-row 30-inch cultivators, and this past year, my two daughters (both of whom are married and have children) did the cultivating for me. With the cultivation this year, we put on an additional 30 units of 28 percent liquid nitrogen. We just dribbled this in between the rows, and the corn looked exceptionally good, even into September through the hot dry period that we had. I think that adding nitrogen during cultivation is a practice that I am going to continue.

The 25th of September is our target date to open up the fields and get the dryer equipment started for the harvest season. Along with farming, we have a farm implement business, which is mainly Buffalo Farm Equipment, but we also

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Table 3. Cedar Valley Farm Business Assoication, 1983 Farm Business Analysis

By Duane Murken, Consultant

Comparisons, 1974 to 1983

	1974	1975	1976	1977	1978
Net farm income	$55,958	$44,810	$35,705	$35,880	$63,761
Management return	$19,917	$3,660	$117	-$2,380	$22,232
Gross profits	$110,268	$107,971	$143,061	$104,895	$149,603
Gross profits per $1 of cash expenses	$2.03	$1.70	$1.57	$1.51	$1.74
Gross value of crops per rotated acre	$251	$213	$206	$185	$225
Return per $100 of feed	$103	$145	$124	$158	$197
% return on investment	11.8	7.9	4.9	4.5	8.7
Total farm acres (average)	443	442	455	468	466
Cash income	$134,854	$136,811	$137,980	$140,554	$170,301
Cash expenses	$75,206	$85,034	$88,184	$93,543	$123,674
# of hogs sold	444	406	474	474	491
Average sale price	$36.41	$53.28	$43.05	$41.58	$50.31
# of cattle sold	76	60	77	87	85
Average sale price	$44.32	$42.00	$39.46	$39.82	$50.67
Average corn acreage/average yield	193/113	198/106	215/108	220/94	219/125
Average bean acreage/average yield	111/31	97/40	88/35	105/39	99/43
Corn sale price	---	---	---	$2.02	$2.00
Bean sale price	---	---	---	$7.06	$6.04
Interest paid	$5,031	$5,814	$6,659	$8,440	$13,702
Depreciation expense	$9,980	$11,859	$12,246	$13,296	$14,925
Machinery and power cost per acre (fuel, depreciation, repairs, utilities, custom work)	$52	$59	$60	$61	$70
Average age of farmer	43	44	43	43	43
Fuel costs	---	---	---	---	---
Repair costs	---	---	---	---	---

Cedar Valley Farm Business Association, 1983 Farm Business Analysis (continued)

	1979	1980	1981	1982	1983
Net farm income	$56,753	$69,688	$35,353	$38,793	$41,167
Management return	$3,111	$9,856	-$44,757	-$32,513	-$18,582
Gross profits	$142,361	$170,411	$135,040	$149,922	$153,118
Gross profits per $1 of cash expenses	$1.66	$1.69	$1.35	$1.34	$1.36
Gross value of crops per rotated acre	$257	$332	$292	$255	$273
Return per $100 of feed	$164	$139	$139	$181	$137
% return on investment	7.2	8.2	4.3	4.5	4.8
Total farm acres (average)	464	465	430	454	459
Cash income	$165,377	$199,826	$190,595	$188,499	$218,542
Cash expenses	$113,286	$132,777	$125,626	$136,161	$150,519
# of hogs sold	487	453	490	495	544
Average sale price	$43.97	$40.15	$47.55	$54.38	$47.21
# of cattle sold	64	72	66	48	63
Average sale price	$69.88	$68.02	$63.47	$58.22	$60.01
Average corn acreage/average yield	220/142	242/123	229/137	229/135	157/98
Average bean acreage/average yield	112/43	113/44	105/44	118/42	112/40
Corn sale price	$2.30	$2.61	$2.84	$2.48	$2.90
Bean sale price	$6.74	$6.53	$6.92	$5.86	$6.71
Interest paid	$12,309	$17,376	$19,612	$20,765	$22,604
Depreciation expense	$15,625	$15,628	$16,559	$18,374	$22,005
Machinery and power cost per acre (fuel, depreciation, repairs, utilities, custom work)	$78	$82	$84	$89	$93
Average age of farmer	42	44	44	44	45
Fuel costs	---	---	---	$6,927	$6,192
Repair costs	---	---	---	$6,166	$6,436

Percentage of change betweeen 1974-83

Cash income	162% increase in 1983	Depreciation expense	220% increase in 1983
Cash expense	200% increase in 1983	Machinery and power cost per acre (fuel, depreciation, repairs, utilities, custom work)	179% increase in 1983
Interest paid	449% increase in 1983		

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carry electric wheel wagons, Broyhill sprayers, Dickey John Monitors and Amsoil synthetic oil. My son and two sons-in-law have been working with me, although my son decided to go back to school this fall. During the time we are not in the fields, we do a lot of traveling and calling, and our efforts are put toward selling machinery.

We do a lot of experimenting, and it is beginning to pay off. We've been working on a two-row horse-drawn corn planter. It's surprising how many inquiries we've had, especially from the Amish. We have made progress this year, but we don't feel it is ready to be sold commercially yet.

Another project that you will be hearing about in the near future is a hydraulic drive that replaces the transmission on your corn planter. The unit is programmable; it becomes an acre counter; it has a tactometer and digital readout; and it gives you miles-per-hour similar to a combine except that it uses direct drive from a wheel. Also, it works on all sizes of planters and has a 32-position dial that changes your planting rate 2 percent at a time so you can change your plant population from 17,300 plants to 33,000 plants on the go. You can change it instantly by sitting in the cab and turning a dial. This year, these units are going to be available in limited quantities through Fleischer Manufacturing.

Profit Tillage

By Dan Stadtmueller
Farmer from Monticello, Iowa
(Presented at the central regional conference.)

My wife Diana and I farm about 1,000 acres of row crop in Jones County, Iowa. Our soils are in the Kenyon-Clyde soil association, and the land is gently rolling, ranging from 3 to 6 percent slopes. We have some heavy low ground and some sandy knolls with considerable risk of erosion. Therefore, I have always been looking for lower-cost methods of producing corn and soybeans that also hold soil erosion losses to acceptable limits.

I started chisel plowing and planting in corn stalk residue in 1967, and it worked well until we had problems with leaf diseases (which we blamed on crop residue). We went back to plowing; but in 1970, everyone found out that the leaf diseases were caused by "T" cytoplasm in the seed corn, so we went on with chiseling, disking and planting.

In 1975, after a series of wet and late springs, I purchased a six-row 36-inch Buffalo till planter and cultivator and started into the ridge till system. Since then, the system has evolved rather than been changed. Problems that have arisen are solved, and I don't plan to ever go back to the plow.

In 1977, I put together a low-cost, high-speed stalk chopper consisting of Liliston chopper modules mounted on a toolbar. I converted the Buffalo planter to plateless with John Deere seed boxes and insecticide hoppers. At this time, we broadcast our P and K, used a liquid starter with the planter and broadcast herbicide as we planted. This program worked reasonably well, but we weren't setting any yield records.

In 1979, we evolved into a new era by going to a John Deere 7000 pull-type planter with a mechanized dry fertilizer system. We pull an Energro Olson fertilizer cart, which holds 5 tons of dry fertilizer. The tongue of the cart is an auger, and we can fill the fertilizer boxes on the planter as we plant. We have reduced the total amount of P and K used annually and have not broadcast any fertilizer for five years. We use a cold blend of half DAP (Diammonium phosphate) and half 0-0-60. During this period, we have not experienced any yield reductions, but on the contrary have had the highest farm averages ever and have won some yield contests.

I'm a firm believer that deep-applied side-dress anhydrous ammonia is the most effective and efficient method to provide nitrogen for corn in ridge till and no-till systems. I have side-dressed all of my corn with a three-knife applicator--one knife between each pair of rows--for the past eight years. I have two tubes on each knife to allow for heavy rates at high speeds. (7 or 8 miles per hour) I drive in the same track and take the same six rows as I plant. Side-dress nitrogen seems to provide consistently high yields for ridge till systems.

I have done a lot of banding of herbicides as a cost control measure. Lasso banded directly behind the planter gives consistently good grass control in the row, whether it rains or not. My current favorite herbicide treatment for corn is Lasso banded at planting time followed by a postemergent application of 2 pounds of Bladex 80W broadcast. The Lasso keeps grass out of the row, and the Bladex takes out all broadleaves. In some years, the Bladex also controls grass between the rows well enough that only the ridge-rebuilding cultivation at layby time is necessary. For soybeans, I am going to use an early preplant application of herbicide such as Bladex to keep down all early weed growth. Banded Lasso will be used at planting time and spot treatments of postemergent herbicides will be used for some broadleaf weeds.

One feature of my system is that it has developed into a controlled traffic pattern to aid in reducing compaction problems. The stalk chopper, the planter, the cultivator and the side-dress operation all drive in the same track. The only time any other row space is driven on is during harvest when the drive wheels of the combine run on different areas. Even our tractor and auger cart are set in a 72-inch tread so they run in the same track as all the spring operations.

One area of increasing interest is interplanting of corn and soybeans in the same field. I have one farm with light soils, long slopes, and many rocky areas. It had been in continuous corn; and during 1976, a very dry year, poor yields were experienced. During that year, corn after soybeans yielded 30 to 40 bushels per acre more than corn after corn. Due to erosion considerations, I didn't want to put the whole farm in soybeans at one time; so, because I was ridge planting, I planned to rotate the field out of continuous corn by planting 12- and 24-row strips of corn and soybeans.

About this same time, I read articles by Dr. Keith Whigham at Iowa State University stating that higher net returns per acre were possible from interplanting due to higher yields from the border row effect. The border row effect more than offset any yield reduction in soybeans due to shading from corn. In 1978, I planted about 100 acres of 12- and 24-row corn and soybean strips plus a small plot of 6- and 6-row strips. The 6 and 6 worked well, and I rapidly expanded until nearly half my acres were of this pattern by

1981 and 1982. The best yield response, 25 or more additional bushels of corn per acre, comes during the best growing seasons.

With this pattern, some care must be taken to work out the fertilizer and herbicide programs, and overall weed control is more difficult. During 1982, I had some serious common stalk borer problems caused by grassy weeds developed when I didn't get the final cultivation and ridges built during the summer of 1981. It now appears that I can control these stalk borers by using Pydrin with a postemergent herbicide. I plan now to substantially increase my area of corn and soybean interplanting. My advice to others interested in trying this would be to select a low weed pressure field, hopefully orient the rows north and south and develop compatible herbicide, fertilizer, and equipment procedures.

Ridge till systems dramatically cut production costs without reducing output. Most ridge till users talk in terms of saving $30 or more per acre. On many farms, this saving adds up to a lot of money. However, with the banding of all P and K, and the side-dressing of ammonia, substantially more can be saved per acre. Additional innovations, such as the interplanting of corn and soybeans, can further increase output without increasing production costs. So, in summary, the system I use has really turned into a profit tillage program and has made the past few years the most profitable I have ever had.

Farming and Protecting the Land

By Robert D. Walker
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(Presented at all three regional conferences.)

"T by 2000" is the focus of the Illinois erosion-control program, which had its origins in the State Water Quality Management Plan of 1979. Essentially, the goal of the program is to reduce erosion to a tolerable level--to the T level--on all Illinois soils by the year 2000. As an intermediate goal, the hope is to control erosion by 1988 on gently sloping land where erosion can be controlled with conservation tillage.

January 1, 1988 is only three years away. So what can be done?

Conservation Tillage

Conservation tillage offers a practical method of reducing sheet and rill erosion, but other practices will be needed to supplement conservation tillage on many fields. These additional conservation practices may include contour farming, terraces, grass waterways, diversions, dry dams, structures, or sod in the rotation.

Let me begin by defining conservation tillage as I use the term. Conservation tillage is any tillage system that can be expected to provide a substantial soil erosion reduction when compared to conventional tillage (moldboard plowing followed by two or more secondary tillage operations). Early forms of conservation tillage included plow-plant, wheel-track plant, and strip tillage.

Conservation tillage systems have changed as we have learned more and as new farm equipment has been developed. Today, the three most popular systems used in Illinois are no-till, ridge planting, and reduced tillage (in which the chisel plow or disk replace the moldboard plow as the primary tillage tool). However, there can be many variations within each system.

The chisel plow, as a primary tillage tool, has been the most widely adopted system by Illinois farmers; but the system as it is often used does not meet my definition for substantial soil-erosion reduction. This is because many farmers make so many passes with secondary tillage that they bury most of the soil-protecting crop residue.

According to the Soil Conservation Service, at least 30 percent of the soil surface must be covered with residue after planting for the chisel or disk system to qualify as a conservation tillage system. The Universal Soil Loss Equation indicates that 30-percent cover generally will reduce erosion by about 30 percent; but recent research shows that a 30-percent residue cover may actually reduce erosion by as much as 40 to 50 percent.

The 'Erosion Months'

By mentioning the problem of making too many secondary tillage passes, I do not intend to imply that we haven't gained in controlling erosion by switching to the chisel plow. The chisel plow often leaves 50- to 60-percent residue cover over the winter, and this can substantially reduce erosion during this period. But, if secondary tillage buries most of the crop residue, the soil will be left unprotected from planting time until the new crop provides a protective canopy over the soil. This can be a problem because 36 percent of the yearly potential for soil erosion occurs between April 1 and July 15 in northern Illinois. In central Illinois, 39 percent of the erosion potential occurs between those dates; and in southern Illinois, the figure is 38 percent.

The April 1 to July 15 period has always posed a problem for clean tillage. That is why the major thrust of conservation tillage has been to provide soil cover with crop residue during spring and early summer. A 10 to 20 percent soil cover may be adequate to control wind or water erosion on level land, but it may not be enough to bring erosion to tolerable levels on sloping land.

Before you can figure out what it takes to bring erosion on your land to tolerable levels, you need to know the severity of soil erosion on your land. To do this, you can use the Universal Soil Loss Equation, which takes into consideration a variety of figures, including slope length and steepness, rainfall, and soil type. To learn how to use the soil loss equation, obtain a copy of <u>Estimating Your Soil Losses with the Universal Soil Loss Equation</u> from your local county Extension adviser. Also, your local conservationist can assist you with the estimates.

Let me illustrate what the equation can do for you in various regions of the state...

Northern Illinois

Assume that your northern Illinois farm has either a Tama or Saybrook soil. Tama is found in northwestern Illinois and Saybrook in northeastern Illinois. Both soils have the same "erosion index," which indicates how susceptible a soil is to erosion; and both soils have a soil-loss tolerance level of 5 tons per acre per year. (When the erosion rate <u>exceeds</u> the tolerance level, that means the potential soil productivity is being reduced.)

In this example, let's assume that the slope is 4 percent and 300 feet long, with a corn-corn-soybean rotation. The soil-loss equation will then project that the average annual soil loss could range from 11 tons per acre annually with conventional tillage up and down the hill to 2 tons per acre annually with no-till on the contour (see Table 1).

Table 1.

Northern Illinois

Tama-Saybrook soils, 4% slope, 300 feet long, T value = 5 tons per acre annually

	Soil loss (tons per acre annually)	
C-C-Sb rotation	Up and down hill	Contour
Conventional tillage, spring plow	11	6
Chisel, 30% soil cover	8	4
No-till, 70% soil cover	3	2
C-C-G-M rotation		
Conventional tillage, fall plow	5	3

Also, note that if you switch the rotation to corn-corn-grass-meadow, erosion can be reduced to 5 tons per acre even if you use conventional tillage with fall plowing up and down the hill. And if you use a corn-corn-grass-meadow rotation with conventional tillage on the contour, you can further reduce erosion to 3 tons per acre per year. Sod crops in the rotation are quite helpful in reducing soil erosion because they provide a good protective cover, as well as grass roots that help to resist erosion for two years.

This example was on prairie soils with gentle slopes. However, the soil erosion problem gets much more severe on steeper slopes and with soils that have less organic matter. To illustrate soil loss on steeper land, let's look at a Fayette soil (northern Illinois) with an 8 percent slope that is 150 feet long.

Table 2.

Northern Illinois

Fayette soil, 8% slope, 150 feet long, T value = 5 tons per acre annually

	Soil loss (tons per acre annually)	
C-C-Sb rotation	Up and down hill	Contour
Conventional tillage, spring plow	26	13
Chisel, 30% soil cover	18	9
No-till, 60% soil cover	9	5
C-Sb-G-M rotation		
Conventional tillage, spring plow	10	5
Chisel, 30% soil cover	7	4
No-till, 60% soil cover	3	2

Table 2 once again shows the importance of hay and meadow in controlling erosion. In fact, as slopes exceed 8 percent, a sod crop usually will be necessary to bring erosion within the tolerance level, even if you use no-till.

Central Illinois

Table 3 illustrates the same principles for a central Illinois situation. In the northern Illinois example, the 30-percent soil cover with a system up and down the hill only reduced erosion to 8 tons per acre per year. But in central Illinois, the same 30-percent soil cover was enough to bring erosion within the 5-ton soil-loss tolerance level. This shows how a different soil and slope -- in this case, a Flanagan soil with a 3 percent slope -- can alter the rate of erosion.

Table 3.

Central Illinois

Flanagan soil, 3% slope, 300 feet long, T value = 5 tons per acre annually

	Soil loss (tons per acre annually)	
C-Sb rotation, fall plow	Up and down hill	Contour
Conventional tillage	8	4
Chisel, 30% soil cover	5	3

Southern Illinois

The principles for controlling soil erosion in southern Illinois are the same as those for central and northern

Illinois. However, average rainfall intensities in southern Illinois are greater, and many of the southern Illinois soils have claypans or fragipans. These soils have less organic matter, making them somewhat more erodable than soils in central and northern Illinois. The following example with Ava silt loam soil is somewhat typical for southern Illinois.

Table 4.

Southern Illinois

Ava silt loam, 5% slope, 250 feet long, T value = 4 tons per acre annually

	Soil loss (tons per acre annually)	
C-Sb rotation, spring plow	Up and down hill	Contour
Conventional tillage, spring plow	23	11
No-till, 40% soil cover	10	5
C-Sb-W-H rotation, spring plow		
Conventional tillage, spring plow	9	4
Chisel, 30% soil cover	6	3
No-till, 60% soil cover	3	2

The Trend Toward Row Crops

The Illinois erosion problem has become more severe with the gradual increase in row crops. In 1930, Illinois farmers grew about 8 million acres of corn and 1 million acres of wheat, for a total of about 9 million acres of row crops. By 1980, they were growing about 11 million acres of corn and over 9 million acres of soybeans for a total of 20 million acres of row crops.

A typical rotation in the 1940s would probably have been corn-corn-oats-hay on most gently sloping land. But today it most likely would be a corn-soybean rotation. In 1940, a Catlin or Tama soil with a 5 percent slope in central or northern Illinois would have had an erosion rate of about 7 tons per acre annually for up and down hill farming and 4 tons per acre with contour farming. Erosion on the same soil today, with a corn-soybean rotation instead, would be about double with conventional tillage. (See Table 5)

Table 5.

Central or Northern Illinois		
Catlin or Tama soil, 5% slope, 200 feet long, T value = 5 tons per acre annually		
	Soil loss (tons per acre annually)	
C-C-O-H rotation (1940)	Up and down hill	Contour
Conventional tillage, spring plow	7	4
C-Sb rotation		
Conventional tillage, spring plow	15	8
Chisel, 30% soil cover	10	5
No-till, 50% soil cover	5	3

Production And Erosion

Illinois is a very productive state. We have some of the best soils in the world, as well as some that are not so good. Also, we usually have adequate rainfall and temperatures to produce excellent agricultural crops. But soil erosion can reduce the long-term productivity of these soils, particularly shallow and sloping soils.

What obligations does a farmer or landowner have to conserve the soil that he owns or farms? We all know that future generations will depend on the soil for their food, fiber, and to a large extent, their standard of living. On the other hand, farmers today are confronted with the task of trying to make a living today. We must find methods that are both practical for landowners to maintain soil productivity and water quality while providing a decent standard of living. It will not be easy, but I am confident that we can do it. Perhaps the ideas that you receive at the conference today will be a major step forward in meeting the state erosion goals. As for the economic constraints, they may need to be partly overcome by federal farm program policy.

The Effect on yields of Tillage Systems, Crop Management, and Soil Characteristics

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(Presented at the northern regional conference.)

Farmers in the Corn Belt states are changing tillage practices more rapidly than they were 10 or even five years ago. Current interest in conservation tillage is due to many things, but primary on that list is a search for ways to increase net profit. While reduced tillage offers an opportunity to reduce production costs on many farms, yield differences due to tillage practices (if they exist) often have a greater influence on net profit.

Evaluating the effect of specific tillage-planting systems on yield is not a simple task, because it may be influenced by several associated practices, such as pest control, equipment adaptation, fertilizer application, form of fertilizer, and soil properties. However, research and farmer experience in the eastern Corn Belt during the past 20 years have identified the major factors that influence the success of reduced tillage systems. These include soil drainage, previous crop, length of growing season, proper nitrogen application, pest problems, and operator management skills.

Soil Drainage

Most research and experience in the Corn Belt indicates that as soil drainage improves, the need for tillage decreases. This is illustrated by results from a seven-year continuous corn study in northern Indiana (Table 1). Tillage experiments were conducted on a well-drained, sandy loam soil (Tracy) and on a poorly drained, dark loam (Runnymede).

While all no-plow systems were as good as or better than moldboard plow tillage on the well-drained soil, no-till yields were reduced on the poorly drained soil. Lower soil temperatures and excess wetness early in the growing season are common on poorly drained soils, and both problems are accentuated when the prior year's crop residues are left on the surface and the soil is not loosened with tillage.

Table 1. Corn Yield Response to Tillage Systems, Northern Indiana (Griffith, 1982)

	Well-drained Tracy sandy loam	Poorly-drained Runnymede loam
	--------bushels per	acre----------
Moldboard plow, disk twice, plant	122	134
Chisel, field cultivate, plant	125	130
Ridge plant in last year's ridges	138	133
No-till plant	124	115

Previous Crop

Several long-term studies have shown the positive effect of crop rotation on corn yields, and the same response is often found with soybeans. The positive influence of rotation is even more important when no-till planting on poorly drained soils, as indicated in results from a nine-year study near Lafayette, Indiana (Tables 2 and 3).

No-till corn yields averaged 14 bushels per acre less than plowed yields for nine years of continuous corn, but only five bushels per acre less when corn followed soybeans. No-till soybean yields, meanwhile, were reduced by six bushels per acre for continuous soybeans, but only three bushels per acre when soybeans followed corn. Continuous crops reduced yields with all tillage systems, but the reduction was usually greater for no-till planting than for systems that included some kind of tillage. Other experiments have shown a similar no-till response to previous crop when corn is rotated with sod. Note that ridge planting compared favorably with plowing in both rotation and a monoculture such as continuous corn.

Table 2. Corn Yield Response to Tillage and Previous Crop, Chalmers Silty Clay Loam, Lafayette, Indiana (Unpublished data)

	Continuous Corn		After Soybeans	
Tillage system	1980-1983 avg.	1975-1983 avg.	1980-1983 avg.	1975-1983 avg.
	------------bushels	per	acre------------	
Fall plow	168	165	180	171
Fall chisel	159	158	177	169
Ridge planting	165	---	183	---
No-Till	143	150	176	166

Table 3. Soybean Yield Response to Tillage and Previous Crop, Chalmers Silty Clay Loam, Lafayette, Indiana (Unpublished data)

Tillage system	Continuous Soybeans 1980-1983 avg.	Continuous Soybeans 1975-1983 avg.	After Corn 1980-1983 avg.	After Corn 1975-1983 avg.
	bushels per acre			
Fall plow	54	51	57	53
Fall chisel	50	48	54	53
Ridge planting	51	--	55	--
No-till	49	45	52	50

Several factors may be involved in the results of these studies. For instance, soil physical properties near the surface often improve with shallow or no-till planting when corn is rotated with other crops. Reduced residue after soybeans, or the moisture transpired by letting sod grow until corn planting, both lead to improved soil drying and warming. Rotating crops may also provide fewer pest problems by interrupting the life cycle of pests that are not controlled by pesticides.

Because residues are concentrated closer to the seed with no-till planting or shallow tillage, the possible toxic effect of this decaying residue on germination and seedling growth of the next crop (allelopathy) is currently receiving much attention. This effect has been documented in greenhouse studies when corn follows corn, but its importance in the field is not clear. An allelopathic effect when no-till corn follows corn could contribute to reduced plant growth and yield.

Length of Growing Season

Tillage systems that leave most of the soil surface covered by residue have generally been successful on well-drained soils in the central and southern Corn Belt, and in the states further south. For example, in Wisconsin, Minnesota, and Canada, trials have often shown reduced yields with surface residue systems compared to clean-tilled systems. And in Indiana, results are usually better in the southern than the northern part of the state, when planting is done in heavy residues.

Reduced soil temperature, caused by the residue cover, apparently has greater effect on plant growth and yield in the more northern latitudes. Delayed planting, to allow soils to become drier and warmer, would be more likely to reduce yield potential in northern latitudes than in southern latitudes because of the shorter growing season.

Proper Nitrogen Fertilization

Surface application of nitrogen fertilizer (usually 28 percent liquid) is common with no-till systems and is often used with ridge planting. However, this nitrogen is subject to loss through volatilization of urea, through denitrification of nitrates, and through the use of nitrogen by bacteria in decaying crop residues. All of these potential loss situations are aggravated by no-till planting or ridge planting.

The yield and ear leaf analysis data reported in Table 4, an average of seven experiments, shows that nitrogen was used most efficiently when injected beneath the soil surface with no-till planting. Applicators are now commercially available to do this. Where nitrogen is surface-applied and broadcast at planting time on no-till corn, the rate may need to be increased by 15 to 20 percent in anticipation of extra losses.

Table 4. Effect of Nitrogen Source and Placement on No-Till Corn Yield and Ear Leaf N, Indiana (Mengel, 1982)*

N Treatment	Yield	Ear Leaf Nitrogen
	bu/acre	%
NH_3 injected	139	3.06
28% liq. injected	135	2.85
28% liq. surface	118	2.48
Urea surface	123	2.57

* Based on an average of seven experiments conducted from 1978 through 1980.

Pest Problems

Weed, insect, disease, and rodent control sometimes become more difficult or more expensive or both as tillage is reduced. During the past 15 years, many yield reductions reported by farmers were caused by poor pest control, especially weed problems.

Available technology now allows control of most pests with conservation tillage. However, this technology is often more expensive than control methods that include more tillage, and it requires greater skills in recognizing pest problems and applying proper chemicals.

Skills and Attitude

The attitude of the landlord, farmer, and hired labor towards a new tillage system also is important. If maximum yields are to be realized, everyone must understand the advantages to be gained with the new system, be willing to

learn the new skills needed and take time to fine-tune the system to a specific set of equipment and soils.

Matching Tillage to Soil

Most tillage research in the Corn Belt shows that response to tillage is related to soil characteristics. A logical first step, then, for farmers who plan to change tillage systems, would be to choose a system that is well-adapted to their soils.

To help farmers choose a new tillage system, several states have rated adaptability of certain tillage-planting systems to groups or classes of soils. In Ohio, soil series were placed in five tillage groups according to soil properties and their influence on no-till planted corn.

For Indiana, Purdue University has published a guide for matching tillage systems to soil types. All named soil series are placed in one of 23 soil-management groups based on drainage and texture. Then eight different tillage-planting systems are rated as to their adaptability to soils in each of the 23 groups.

Tillage systems range from fall plow conventional tillage to no-till planting and are rated from 1 (well adapted) to 5 (not adapted). Both yield potential and erosion potential were considered in making the ratings. Originally, the ratings were for corn after corn, but they have recently been modified for corn after soybeans as well.

Table 5 gives three examples of soils that are often found on central Indiana farms, and it provides tillage system ratings for these soils. Brookston is a poorly drained, dark-colored silty clay loam; Crosby is a nearly level, somewhat poorly drained silt loam with 2 to 3 percent organic matter; and Miami is a well-drained silt loam with slopes often exceeding 6 percent. Note that no-till is rated down on the poorly drained soil due to lower yield potential, and plowing and chiseling are rated down on the sloping soil due to greater erosion potential.

Tillage system ratings for corn after soybeans are given in parentheses where they differ from corn after corn ratings. In general, corn after soybean no-till ratings improve on poorly drained soil because residue cover after soybeans is less than after corn, while systems with full-width tillage (chisel, disk, or moldboard) are rated lower on sloping soils due to less protection from erosion. Note that the ridge planting system receives good ratings on all three soils.

Table 5. Adaptability of Tillage Systems to Three Indiana Soil Series (Galloway, 1977)

		Tillage system					
Soil Series	% slope	Fall plow	Spring plow	Fall chisel	Spring disk	Ridge planting	No-till
		Rating*					
Brookston (poorly drained)	0-1	1	3	1	2	1	3(2)
Crosby (somewhat poorly drained)	1-3	2	2	1	2	1	2(1)
Miami (well-drained)	0-6	5	2(3)	2(3)	2	1	1

* 1 = well adapted, 5 = not adapted. These are ratings for continuous corn, with the exception of numbers in () for corn after soybeans.

Yield Coefficients

Although the preceding ratings are helpful in choosing which tillage systems to consider, they do not provide a means of actually measuring yield potential. In response to this need, an interdepartmental group of researchers and Extension specialists at Purdue University, using previous tillage system ratings as a guide, have suggested "yield coefficients" for different tillage systems -- coefficients that show the effect of tillage on productivity. The coefficients are not based on yield comparisons in any one experiment, but they do reflect research and experience throughout the eastern Corn Belt.

Yield coefficients for six tillage-planting systems are given for both continuous and rotational corn (Table 6). The tillage-planting systems include fall plow, fall chisel, spring plow, spring disk, ridge planting, and no-till. Within each table, coefficients are given separately for three groups of soils -- poorly drained, somewhat poorly drained, and well-drained. (These soil groups are defined in more detail in table footnotes.)

Within each soil group and under any given tillage system, rotational corn has greater yield potential than continuous corn. Also, for a given soil group and cropping sequence, tillage systems differ in yield potential. The conservation tillage systems (chiseling, ridge planting, and no-till) show greater yield potential than conventional tillage (fall plow) on those soils where wind and water erosion control are most common (Group III).

These yield coefficients reflect average early-May planting dates. As planting is delayed into late May or later, the spring disk, ridge plant and no-till systems will compare more favorably with plow systems. But with earlier planting, conservation tillage systems will compare less favorably than shown.

Table 6. Corn Yield Coefficients Expected for Various Crop Rotations, Tillage Systems and Soil Types in Indiana. (Doster, 1983)

Cropping sequence and tillage system[1]	Expected yield coefficient for corn on soil group[2] I	II	III
Continuous Corn			
Fall plow	1.00[3]	1.00[3]	1.00[3]
Fall chisel	0.97	1.02	1.05
Spring plow	0.93	1.00	1.05
Spring disk	0.95	1.00	1.05
Ridge planting	1.00	1.02	1.10
No-till	0.90	0.95	1.10
Rotation Corn			
Fall plow	1.07	1.07	1.07
Fall chisel	1.07	1.07	1.13
Spring plow	1.00	1.07	1.13
Spring disk or field cultivate	1.07	1.07	1.13
Ridge planting	1.07	1.07	1.18
No-till	1.05	1.07	1.18

[1]Tillage system descriptions include:

Fall plow -- fall moldboard plowing, 1-3 spring passes to prepare seedbed.

Fall chisel -- same as fall plow, except a chisel plow is substituted for the moldboard plow. An offset or heavy tandem disk system would have similar yield coefficients.

Spring plow -- same as fall plow, except moldboard plowing is done in the spring.

Spring disk or field cultivate -- 1-3 spring passes with a disk or field cultivator to prepare seedbed.

Ridge planting -- planting into wide tilled strips on pre-formed ridge tops (no other tillage operation at planting).

No-till -- planting into very narrow tilled strips through old-crop residue (no other tillage operation).

[2]Soil group descriptions include:

I -- Dark, poorly drained silty clay loams to clays, 0-2% slope. Examples: Brookston and Chalmers.

II -- Light (low organic matter), somewhat poorly drained silt loams to silty clay loams, nearly level. Examples: Fincastle and Blount.

III -- Light, well drained, shallow terrace soils, sands, sandy loams and silt loams with 3% or greater slope, i.e., most soils that are subject to wind or water erosion and/or drought. Examples: Bedford and Fox.

Soils not included in these groups are mucks, bottomlands, dark sands with high water table, and light, flat soils over fragipans (such as Clermont and Avonburg). See Purdue publication AY-210, "Adaptability of Various Tillage-Planting Systems to Indiana Soils" for information relating tillage to specific soil series for corn production.

[3]Fall-plow tillage system with early-May planting is used as a reference point (1.00) for each soil group, but actual yield potential may be different between soil groups. As planting is delayed, the spring disk and no-till systems compare more favorably with the plow systems in soil group I. With earlier planting (April) in soil group I, these no-plow systems compare less favorably than shown.

In contrast to corn, less is known of the true relationship among tillage system, soil type and soybean yield due to the limited amount of research and practical experience available at this time. However, available knowledge indicates that the same trends illustrated for corn after corn also apply for soybeans after corn (Table 6). For instance, yield potential for continuous soybeans should be reduced with all tillage systems; and as the planting date is delayed, no-till soybean yield potential improves relative to other systems. No-till double-crop soybeans have consistently produced better yields than other tillage systems used for double-crop, even on poorly drained soils.

To use the table to estimate expected long-term yield as tillage systems are changed, let fall plow be the "standard" practice with a coefficient of 1.00 and assume (or determine) an actual yield per acre for this practice in a particular soil-rotation situation. Finally, multiply this yield by the coefficient given for a second system. The result is a yield potential for the second system, which can then be compared to the fall plow yield.

For example, if you assume that fall plowing on a Group III soil will produce 120 bushels of corn per acre, a switch to no-till planting should increase yield to 132 bushels per acre. (A no-till coefficient of 1.10 multipled by 120 bushels per acre with conventional tillage equals 132 bushels per acre with no-till.)

These yield coefficients are intended for use by farmers, farm managers, economists, and tillage system modelers where on-site yield information is not available. To place most of the soils in Indiana into just three groups for tillage system ratings is, of course, a major oversimplication. Although trends shown by the ratings reflect current knowledge, tillage system relationships for individual soils may vary from those shown. Where local data or experience indicate different relationships, they should be used.

In summary, tillage system yield trials generally reflect the soil and climatic conditions, and the cultural practices under which the trial was conducted. The relation of these factors to reduced tillage success have been fairly well-documented across the Corn Belt.

In addition, our knowledge of the relationship of soil drainage and crop rotation to tillage system yields has allowed the assignment of ratings and yield coefficients to tillage systems. These ratings and coefficients are intended to allow long-term budgeting in the absence of specific, on-site yield information, but are not intended to predict yield in any specific year.

The Economic and Production Effects of Soil Erosion

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Acknowledgments

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Counting The Costs

With the poor farm economy and the increasing costs of crop production, there now is great pressure for more intensive land use. In many cases, this means using the land so intensively that the amount of erosion exceeds the tolerance limits. This is becoming a large problem in many areas of the United States, including Illinois, where much of the land is sloping and used for production of row crops.

Most farmers are aware of the cost of controlling erosion. Costs of constructing terraces, diversions, sod waterways, and other types of structures are available. The costs associated with cover crops, rotations, and other measures are more difficult to determine, but they are real and somewhat measurable in terms of costs. However, the benefits of these and other erosion-control practices are difficult to assess. Because the economic benefits are sometimes unknown, obscure, and often unmeasurable, they are not shown in financial records as are most of the erosion-control costs. Nevertheless, the benefits are just as real.

There are a number of economic losses associated with soil erosion, and a few studies have examined them. Two of the major losses coupled with soil erosion are diminishing soil fertility and decreasing crop yield potential. Although erosion may also increase the costs of other management inputs, such as tillage and chemicals, this paper will only address the two major losses mentioned above.

Soil Fertility Loss

Soil erosion removes topsoil, the part of the soil which has the greatest effect on the characteristics of the soil. Therefore, erosion affects many soil properties — important properties such as soil fertility.

Soil erosion is selective. It removes the finer soil particles and organic matter, which are richer in plant nutrients than the remaining parts of the soil. Many calculations of fertility loss are based on the content of nutrients in the plow layer, a method that underestimates the total loss. However, to charge the total nutrient loss as a financial loss also is not appropriate, because a large portion of the nutrients lost in eroded material would never be available for plant uptake. Consequently, it is necessary to determine what would fairly represent the loss of fertility contained in the soil. For example, erosion on soils that are highly fertile (either naturally or because of fertilizer addition) will result in greater losses.

Table 1 shows the calculated fertility loss for two Kentucky soils with high- and low-availability plant nutrient levels. Losses from the soils are calculated on the basis of a soil erosion rate of 14 tons per acre per year. At this rate, it would take about 12 years to lose an inch of soil.

Estimates of the value of the fertility that was lost varied greatly among the two soils. Using research data from Kentucky, the two extremes of nutrient availability were calculated. In Table 1, the value of nutrient loss ranged from $13.56 per acre on Kentucky soil with high fertility availability to $3.33 per acre on soil with low fertility availability. If these two extremes are averaged, the result is a value of $8.54 per acre, or an equivalent of 61 cents per ton of soil lost.

Table 1. Value of plant nutrients lost when soil erosion is 14 tons per acre per year

Nutrient	Value per pound	Soil Fertility Availability: High	Soil Fertility Availability: Low
		(value of nutrients eroded per acre per year)	
Nitrogen	$0.23	$4.60 (20)*	$0.23 (1)
Phosphorus	0.26	7.02 (27)	1.82 (7)
Potash	0.11	1.54 (14)	0.88 (8)
Calcium	0.004	0.40 (100)	0.40 (100)
	Totals	$13.56	$3.33

*Numbers in parentheses are the pounds of nutrients lost per acre per year.

It is extremely conservative to estimate the value of lost nutrients on the basis of availability to plants. Even at a high level of availability, only a small proportion of soil phosphorus and potassium is available to plants at a given time. But much of these nutrients would become available over time, if they were not eroded from the soil.

In summary, it is difficult to put a value on the nutrients lost from soils due to erosion. It depends on the fertility level of the soil and the availability of the nutrients in the soil. The loss under certain conditions can be considerable and cannot be ignored. Fortunately, the fertility can be replaced; but the cost to do so must be recognized and taken into account.

Loss of Yield Potential

In addition to fertility and organic matter, a number of other soil properties are affected by soil erosion. Some of these are rooting depth, soil tilth, available water-holding capacity, and texture of the topsoils. It is difficult to individually evaluate each of these properties because they collectively affect the yield potential of the soil. In most cases, though, the potential productivity will be decreased as erosion occurs. The yield decrease is usually so slight from year to year that the farmer may not realize it is happening. Therefore, loss in productivity due to soil erosion is usually not considered to be a financial loss.

As the small annual losses accumulate with time, productivity is substantially reduced. But through the application of improved technology -- such as fertilizer management, irrigation, improved varieties, and pest control -- crop yields may continue to increase during and after excessive soil erosion. This concept is presented in Figure 1. It should be pointed out that even if technology increased yields, the yield potential of most soils is still decreased by erosion. Actual yields may continue to rise on moderately eroded soils, but yields do not rise as rapidly or as high as on similar soils with none to slight erosion.

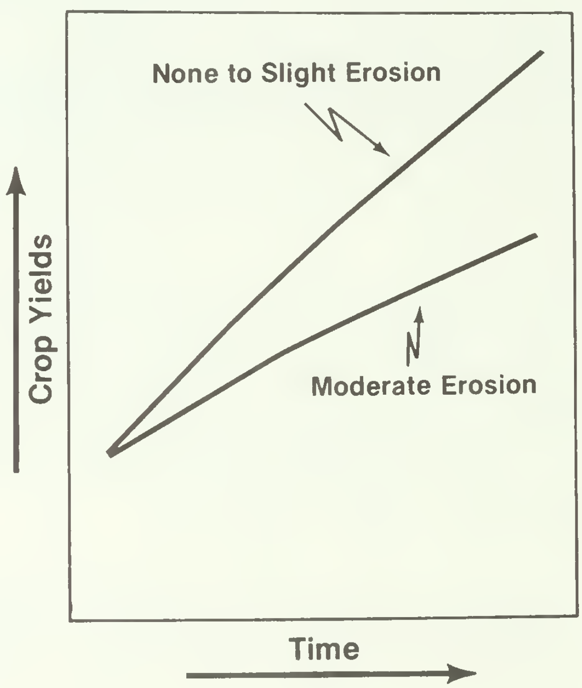

Figure 1. Effect of erosion on soil productivity over time with increased technological inputs.

Another way to view this concept is that more technological inputs are necessary for eroded soils than for uneroded soils. The result is decreased production certainty and increased risk in farming.

The degree to which the productivity of different soils is affected by erosion varies considerably. Deep soil with excellent subsoil properties are virtually unaffected by soil erosion. Increased fertilizer inputs would be required to replace the fertility loss, but the production potential would be changed little, if any. However, deep soil with excellent subsoil usually is not the case. For example, most southern Illinois soils have some undesirable properties in the subsoils that adversely affect yields, or else the soils are shallow.

In either case, erosion will decrease productivity as the topsoil gets thinner and the undesirable subsoil is mixed into the plow layer by tillage. There are few cases in which the loss in productivity has been measured; but some studies give good indications of the effect of erosion on the productivity of soils.

In Kentucky, yields of no-till corn plots located on a moderately eroded silt loam soil were compared to yields in plots on the same soil but with none to slight erosion. This particular silt loam soil tended to be droughty and had a sharp increase in clay content in the subsoil. The comparison was made in 1979, when rainfall was plentiful, yet the average yields on the moderately eroded plots were 12 bushels per acre less than on the plots with none to slight erosion (Table 2).

Table 2. Yield of no-tillage corn on moderately eroded and none- to slightly-eroded Maury silt loam soil at Lexington, Kentucky (average of three years)

Plot Treatment Winter Cover	N	Grain Yield: Moderate erosion	Grain Yield: None to slight erosion	Grain Yield: Decrease due to erosion
	(pounds per acre)	(bushels per acre)		
Corn stalks	0	58	75	18
	44	87	92	5
	88	110	114	4
Rye	0	65	69	4
	44	88	101	13
	88	117	126	9
Crimson clover	0	67	74	9
	44	83	100	17
	88	109	117	8
Big flower vetch	0	63	78	15
	44	105	114	9
	88	95	109	14
Hairy vetch	44	84	112	28
Average	--	87	99	12

In Iowa, a group of soils were studied which were generally deep and had few undesirable subsoil characteristics. A loss of five inches of soil by erosion resulted in a yield reduction of 16 bushels per acre per year. This was an average loss in yield of about 3 bushels per acre per year for every inch of soil lost.

In a Georgia study, the loss in soil productivity was much greater than in Iowa. The soil in Georgia had a high clay content in the subsoil. With a higher degree of soil erosion, productivity decreased. For example, the three-year average yield of corn decreased 42 percent as soil with the high-clay subsoil horizon eroded from 16 inches to 10 inches. This was an average loss in yield of 5.94 bushels per acre per year (Figure 2). The effect on grain yield was greater than on the yield of stover.

Although much of the eroded soil materials accumulates in lower portions of the field, the small, if any, increase in productivity in these areas does not affect the loss of yield potential from soils on the slopes. Soils in low-lying areas of fields are generally already highly productive, and sedimentation from upslope does little to increase their productivity, except where it may improve the drainage condition of the soil.

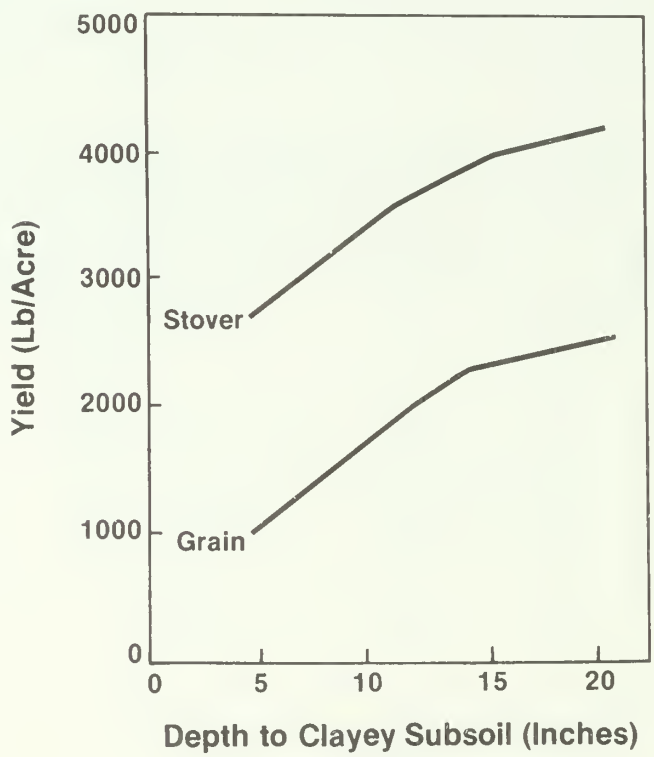

Figure 2. Effect of depth to claypan subsoil on yield of corn grain and stover.

Effect of Depth of Fragipan

Much of southern Illinois' row crop acreage is found on soils with fragipans. These soils have limited depth, and erosion is especially critical. Figure 3 shows the relationship between depth to the fragipan and yields of corn on a fragipan soil in western Kentucky. This is an indication of the expected effect of erosion. The 1978 season was very dry and the effect was great. The yield was about 7 bushels greater for each additional inch of soil above the fragipan. In 1979, the season was excellent with regard to moisture, and the depth of soil had very little effect. In fact, yields were slightly <u>less</u> on the land with deeper topsoil. But if the results for these two years are averaged, each additional inch of soil increased the corn yield by 4.8 bushels per acre per year.

Of course, the depth to a fragipan is not always determined by the amount of accelerated erosion. Factors such as the creation of new soil or the dissection of a landscape by geologic erosion (natural erosion) may be the major determining factors. As erosion occurs on a fragipan soil and decreases the depth of soil to the fragipan, the yields obtained in most years would be expected to decrease, as was indicated in Figure 3. This is particularly true where continued cultivation has allowed moderate erosion over a long period of time.

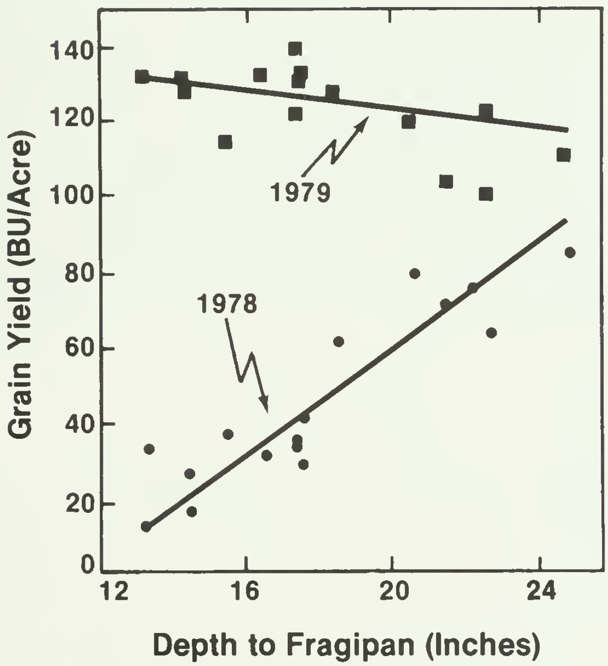

Figure 3. Yield of corn as affected by depth to fragipan in Zanesville soil at Princeton, Kentucky, 1978-79.

Summary

These studies show that the productivity of many soils is decreased by erosion. They also show that the extent to which the productivity is affected will vary greatly with soil type and climatic conditions. It is quite apparent, however, that the effect is a substantial economic loss, which accumulates with time as erosion continues.

There also are costs associated with erosion-control that must be considered. The costs of erosion-control practices are easily realized expenses, while economic losses due to erosion are more subtle. But although they are not easily recognized, the financial losses due to erosion can be high and will probably outweigh the costs of erosion control over the long term.

Machinery Options for Conservation Tillage

By Rich R. Johnson
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(Presented at the northern regional conference.)

Introduction

Just a few years ago, moldboard plowing was the major primary tillage practice used in Illinois. A disk, field cultivator, and harrow were often used for subsequent tillage operations and produced clean, finely tilled seedbeds. Although this was an optimum system in many respects, it allowed more soil erosion than desired on sloping land. Also, the number of tillage passes were greater than many operators could easily handle.

During the past 20 years, the introduction of improved pesticides and farm implements have assisted a trend toward conservation tillage. It should be emphasized at the outset that conservation tillage involves an entire cropping system, an important part of which is the machinery system used. The diverse range of soils, climate, and cropping systems dictate the need for several equipment types that can be used to meet the needs of the conservation tillage concept. Identifying conservation tillage with a specific machine or group of machines can be a serious mistake.

Conservation tillage systems are designed to provide a rough and/or residue-covered soil surface that reduces wind and water erosion. No-tillage represents the extreme in conservation tillage because seed is planted in a previously undisturbed soil, and the only tillage used is that which is necessary to place seed in the soil. Less extreme forms of conservation tillage are usually referred to as reduced tillage because the entire field is often tilled, but in such a way that crop residue is still present on the soil surface at planting time.

Flexibility

Before outlining specific equipment considerations, it is important to emphasize that an operator should build flexibility into his system. For example, University of Illinois research has shown that some poorly drained Illinois soils produce higher corn yields under clean and reduced tillage systems than under no-tillage (Table 1). But when tillage systems are rotated in alternate years, crop yields average higher than where continuous no-tillage is used. Thus, the rotation of tillage systems can cause beneficial responses just as with the rotation of crops and pesticides.

Table 1. Effect of Rotating Tillage on Corn Yields in Continuous Corn, Elwood, Illinois (D.L. Mulvaney)

Tillage	Tillage Rotation	4-Year Average bushels per acre
Zero	Continuous	117
Disk	Continuous	133
Plow	Continuous	134
Zero	Zero/Plow	125
Plow	Zero/Plow	135
Zero	Zero/Disk	122
Disk	Zero/Disk	136

In the corn-soybean rotation that predominates in this region, soil erosion following soybeans is often greater than following corn. Compared to corn, soybeans produce residue that is less in quantity and is subject to more rapid decomposition. Therefore, less aggressive tillage should be used after soybeans. Research at Iowa State University has shown that anhydrous knife applicators can greatly reduce surface residue cover and should be considered as a tillage tool -- especially when managing soybean residue.

Harvest-Time Considerations

Maintaining surface residue is one of the most effective means of reducing soil erosion, and one of the most important steps of residue management begins in the harvest operation. At harvest, the objective should be uniform residue distribution behind the combine. Straw choppers are more effective in spreading residue than are straw spreaders. If headers wider than 15 to 20 feet are used, extended vanes should be used on the straw chopper to assist in providing uniform straw spreading. When properly adjusted, the extended vanes should uniformly distribute residue from even the widest headers.

For those considering ridge tillage, proper spacing of the combine wheels is necessary to prevent destruction of ridges. Dual tires and other packages are often available to minimize these problems.

Tillage Considerations

Virtually any tillage implement can be used effectively in conservation tillage systems if that implement is equipped and operated properly. By using a disk in corn stubble, many producers have devised systems that produce seedbeds with much greater quantities of residue than are commonly present in a chisel system. Even modern adjustable-cut moldboard

plows can leave 20 to 30 percent surface cover when operated in untilled corn stubble at their narrowest width of cut. Operated at their widest width of cut, these same plows will incorporate most residue.

The versatility of several machines is perhaps one of the most poorly understood issues in selecting equipment for conservation tillage. For instance, the John Deere Company currently markets about 30 different sweeps, shovels or spikes for use on chisel plows. Sweeps tend to incorporate small amounts of residue, spikes incorporate intermediate amounts of residue, and twisted shovels incorporate large amounts of residue.

In addition, operation speed and depth, previous crop, and sequence of tillage events all affect the amount of residue remaining. In conservation tillage, therefore, the manner in which a machine is equipped and operated can be as important as selection of the particular implement.

There is a trend in the farm equipment industry to provide multicomponent tillage machines. For example, disk gangs have been combined with chisel shanks, field cultivator shanks, and/or harrow attachments, thereby reducing the number of field passes. Also, the strengths of each component can have a complementary effect. When two components are used together, they sometimes can perform better than when used separately. For example, a disk gang in front of sweeps can size and orientate crop residue so that it flows through the machine while the sweeps and harrow attachments both till soil and return residue to the soil surface. The net result can be a tillage machine that both maintains surface residue, yet thoroughly tills the soil.

As for herbicides, some <u>must</u> be soil incorporated; and although others may not require incorporation, they tend to provide more consistent weed control if they are worked into the soil. As in residue management, successful herbicide incorporation is often as dependent on how the machine is equipped and operated as on the general type of implement used. Several implement companies offer spray equipment as a part of the tillage system. For example, spray tanks and nozzle systems can be purchased as a component or an auxiliary attachment to the tillage implement. Sufficient fore-aft spacing is also being provided within some multicomponent tillage tools to allow alternate locations for spray nozzles. In fields with uneven soil surfaces, it may be desirable to locate nozzles after a section of ground-engaging tools that have leveled the soil surface. And in level field surfaces, the optimum nozzle location may be in front of the machine.

Planting Equipment

When planting in reduced tillage seedbeds, most current row crop planters and drills that are used for clean tillage also can be used for reduced tillage. In general, row crop

planters designed to plant in row widths of 15 inches or wider have the capability of no-till planting in a wider range of seedbeds than grain drills designed to plant in row widths of 6 to 10 inches.

Most planters and drills capable of operating under no-till conditions use some type of coulter to open the soil for the seeding device. Each coulter requires several hundred pounds of down force to guarantee penetration in dry, firm seedbeds. For example, no-till planters typically supply 400 to 700 pounds per planter unit, but at least one manufacturer offers a drill that supplies up to 1,200 pounds per planter unit. Heavy-duty drills with close row spacings are available but require more planting units and weight -- both requirements that increase machine cost. Thus, heavy-duty drills capable of no-till planting under adverse conditions are expensive per unit of width.

A number of lighter-duty drills also are available with coulters. These machines have limited ability to no-till plant, but are effective in fields where some full-width tillage has been conducted. In looser soils or fields where irrigation can be used to moisten the topsoil, these machines can effectively serve as no-till planters.

Several row crop planters capable of no-till planting in row widths of 15 to 20 inches have recently been introduced. Compared to no-till drills, these machines can often operate successfully in adverse seedbeds at a lower cost-per-unit width.

Selection of proper coulter type is important for no-till planting. Smooth coulters require the least down pressure for penetration but prepare a very narrow furrow that must be followed by an aggressive furrow opener. Rippled coulters have a straight sharp edge but ripples located beyond the coulter edge do some limited seedbed preparation. Fluted coulters have a curved edge that prepares a seedbed 1 to 2 inches in width. Smooth or rippled coulters generally work better in surface residue and cover a wider range of soil conditions than do fluted coulters.

Compared to fluted coulters, smooth or ripple coulters (1) require less weight to penetrate hard, dry soil; (2) incorporate less crop residue into the seed zone; (3) and operate at higher speeds and in wetter soils without removing soil from the seed zone. The wider seed zone prepared by fluted coulters helps decrease misalignment problems with the seed opener and can be especially advantageous when planting contoured rows.

Cultivation

Cultivation remains an effective low-cost method of weed control. Several companies offer cultivators capable of operating in large amounts of surface residue, including fields that were no-till planted. Cultivators used for

reduced tillage situations generally have more clearance between sweeps and use a shank that requires more force to cause tripping. No-till cultivators typically have a lead coulter followed by a single heavy-duty trip shovel. Disk hillers may be used on either reduced or no-till cultivators. Where skip-row planters are used to plant rows wider than 15 inches, row-crop cultivators also are used in narrow-row soybean production.

Summary

As producers move away from the clean tillage systems of the past, optimum tillage practices are becoming site specific, much like fertilizer and variety recommendations. Optimum tillage practices within a field often change with the crop grown and the pest problems present. In the corn-soybean rotation, more thorough tillage is often desirable after the corn crop, while much less tillage is needed after the soybean crop. This flexibility should be considered when selecting equipment.

Maintaining surface residue is an important objective of conservation tillage. How a machine is equipped and operated is often as important as which particular machine is used. Many of the "newer versions" of older tillage tools have much greater flexibility than was present a few years ago. Uniform residue redistribution behind the combine also is possible and greatly assists in effective conservation tillage.

Effect of Tillage on Soil Fertility

By Robert G. Hoeft
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(Presented at all three regional conferences.)

Throughout much of the grain-producing (corn, wheat, soybean) areas of the United States, conventional tillage has consisted of the use of a moldboard plow followed by two or more secondary tillage operations prior to planting. But in recent years, many producers have shifted away from this system to conservation tillage systems such as reduced tillage or no-tillage. The goal of this paper is to evaluate the impact that changes in tillage systems may have on nutrient availability.

For the purposes of this paper, reduced tillage refers to those systems that have eliminated the use of the moldboard plow for at least two or more years. These systems vary considerably in the intensity of the tillage practiced, with the most intensive system utilizing a chisel plow plus one or more secondary tillage operations. The least intensive system would involve a single disk or field cultivator operation prior to planting.

No-tillage, as the name implies, refers to planting without any tillage. Both no-tillage and reduced tillage have the advantage of saving fuel, labor, and machinery costs. However, the primary advantage of these systems is the conservation of soil and water.

Reduced tillage and no-till both result in less mixing of the soil and less incorporation of the crop residue than conventional tillage. As a consequence, these conservation tillage systems can bring about differences in the distribution of nutrients, surface residue cover, soil moisture, microbial activity, soil temperature, and zones of soil acidity — differences that should be considered when planning a soil fertility program. Most of these changes will have an impact on the availability of both inherent as well as applied nutrients.

Nitrogen

The availability of nitrogen to plants is regulated to a large extent by microbial activity. And microbial activity, in turn, is influenced by factors such as temperature, moisture, and compaction. Therefore, because tillage can sometimes alter these factors, changes in tillage can affect microbial activity and nitrogen availability.

For example, increased residue left on the soil surface by conservation tillage systems conserves moisture by

reducing the rate of evaporation and, in many cases, by reducing runoff and thereby holding more of the water on the land. The increased water content, combined with the light-colored surface residue (which tends to absorb less solar radiation), reduces the rate at which soils warm in the spring, especially in years when weather is unseasonably cool early in the growing season (Table 1). Although the temperature differences are generally small, they still may have a measurable effect on biological reactions, including nitrogen conversions and seed germination.

Nitrogen undergoes six reactions that are biologically influenced. These include mineralization (the release of nitrogen), volatilization, nitrification, denitrification, and immobilization (Figure 1).

Table 1. Effect of tillage on spring soil temperature.

Tillage	Soil Temperature in degrees F.	April 30 - May 30
Moldboard Plow	59.0	
Chisel Plow	59.0	
Disk	57.0	
Zero-Tillage	56.0	

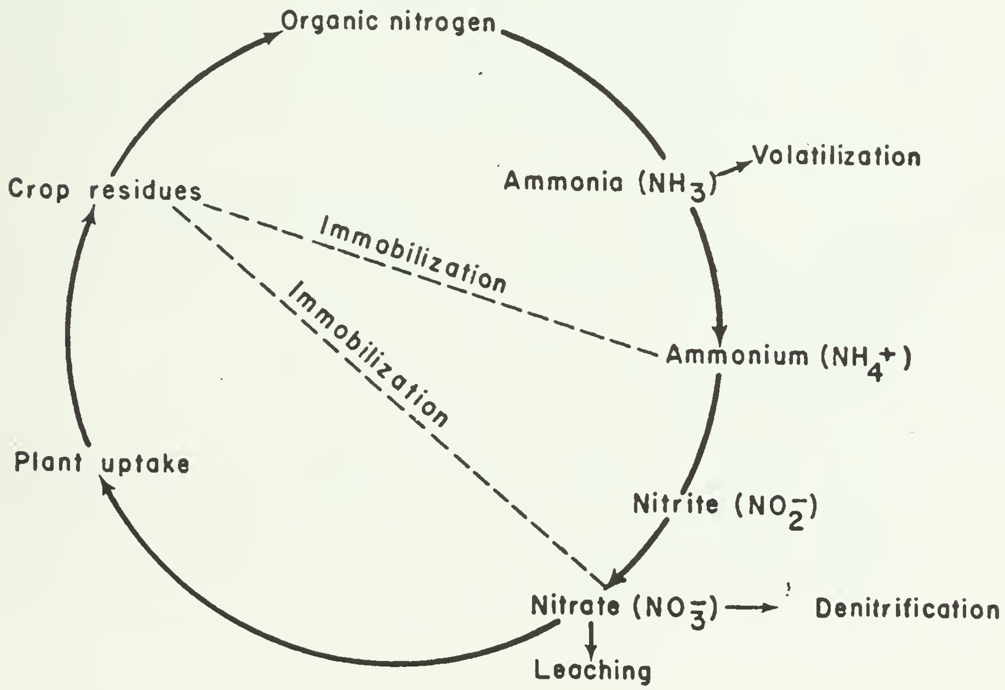

Figure 1. The nitrogen cycle (circled numbers refer to the reactions discussed in the text).

Soils collected from a number of experimental areas around the United States have shown that the levels of potentially mineralizable N in the upper 12 inches of soil are approximately equivalent under various tillage systems. However, no-till has a substantially higher percentage of its total N located in the upper 3 inches. Research also revealed these two facts: The microbial population was higher in the upper 3 inches under conservation tillage than under conventional till; and the populations decreased rapidly below the 3-inch depth under conservation tillage but not under conventional till. Based on this data, researchers concluded that the potential rate of mineralization would be higher with conventional tillage.

In addition, the higher microbial population found in the surface soil under conservation tillage ,as compared with conventional tillage, would create a greater potential for immobilization of surface-applied fertilizer nitrogen. Therefore, the combination of a higher immobilization rate and lower mineralization rate with conservation tillage may result in decreased nitrogen availability.

The conservation of water, which results from conservation tillage, is normally considered to be beneficial; but at some times of the year, excess water may cause problems by increasing the loss of nitrogen through denitrification and leaching. This problem is further complicated because the population of denitrifying organisms throughout the upper 6 inches is much higher for no-till than for conventional tillage (Table 2).

Table 2. Ratio of denitrifying organisms between no-tillage and conventional tillage.

Depth	Ratio of Denitrifiers No-Till/Conventional Till
0-3 inches	7.31 to 1
3-6 inches	1.77 to 1
0-6 inches	2.83 to 1

Because of the increased potential for nitrogen loss by denitrification and/or leaching under conservation tillage, the potential benefits from using nitrification inhibitors is increased. Researchers in Kentucky have observed a positive response to inhibitors during each of three years when corn was grown under a no-till system (Table 3).

Table 3. Effect of nitrification inhibitors for zero-till corn. (Kentucky)

Year	Without Inhibitor	With Inhibitor
	(Yield, bushels per acre)	
1974	49	54
1975	104	130
1976	26	40

An increase in residue cover with conservation tillage also reduces the probability of soil-fertilizer contact with surface-applied materials because residue traps part of the fertilizer. This is of particular concern with urea or urea-containing fertilizers, for a portion of these materials may be lost through volatilization. This loss will occur when the enzyme "urease" coverts urea to ammonia. If it occurs at or above the soil surface, the soil will not be able to absorb the ammonia.

Considerable research has been conducted comparing nitrogen sources under different tillage systems. In an experiment in southern Illinois, for example, surface-applied ammonium nitrate was superior to urea in three comparisons but equivalent to urea in the fourth comparison (Spring 1975) under no-till (Table 4). The reason for this difference in response was that rain was received within a few hours after the urea was applied in the spring of 1975, but in the other three comparisons, no rain was received for several days after fertilizer application. Work at Purdue University also has shown that as tillage is reduced, the potential for nitrogen loss from surface-applied urea-containing fertilizers increases (Table 5).

Table 4. Effect of surface-applied nitrogen sources for zero-till corn.

Nitrogen Source	Time Applied	Nitrogen Rate	1974	1975
		(Pounds per acre)	(Yield, bushels per acre)	
None	--	0	50	76
Ammonium Nitrate	Spring	120	132	160
Urea	Spring	120	106	166
Ammonium Nitrate	June	120	151	187
Urea	June	120	125	132

Table 5. Effect of tillage and nitrogen placement on corn production. (Purdue)

Tillage	Nitrogen Source	
	Anhydrous Ammonia	Urea-Ammonium Nitrate
	(Yield, bushels per acre)	
Moldboard Plow	138	137
Chisel Plow	137	130
No-Till	138	116

Since this early work showed the problems that may exist with surface applications of urea, new application techniques have been developed...techniques that show promise for reducing the potential loss. Two techniques, which have worked well, are the shallow injection of urea-ammonium nitrate solutions and a method called dribble application. With a dribble application, the solution nitrogen is applied in a very narrow band on 30-inch spacings. Work at Maryland has shown that the dribble technique is superior to broadcast applications, but it was not consistently equal to an injection of the urea-ammonium nitrate solution (Table 6).

Table 6. Effect of method of application of urea-ammonium nitrate solution on no-till corn yield at four locations.

Nitrogen Application Method	Location			
	A	B	C	D
	(Yield, bushels per acre)			
Broadcast	99	120	136	160
Dribble	120	157	150	177
Injected	124	168	156	179

Based on research conducted to date, it appears that the best nitrogen management program would be one in which the nitrogen fertilizer is injected into the soil to a depth of at least 4 to 5 inches. Doing this would markedly reduce the potential for volatilization, immobilization, and/or denitrification. Also, producers may want to include a nitrification inhibitor on those fields where denitrification is likely to be a problem in a significant number of years. The second-best application technique for nitrogen under reduced tillage would be a dribble application. And the least efficient technique for nitrogen is a surface broadcast application of urea-containing materials. This is especially true where precipitation is not received within a few days of application.

Phosphorus And Potassium

Under a moldboard plow system, phosphorus and potassium are uniformly distributed throughout the soil to the depth of plowing. But when conservation tillage systems are used, the relatively immobile nutrients, such as phosphorus and potassium, are concentrated in the upper 2 to 4 inches of soil (Table 7). Because of this data, many scientists have been concerned that the lack of nutrient mixing may adversely affect crop growth.

Table 7. Phosphorus and potassium soil test levels at various depths as influenced by tillage.

Soil Depth	Plow	Chisel	No-Till	Plow	Chisel	No-Till
Inches	P (pounds per acre)			K (pounds per acre)		
0-3	74	169	180	300	460	570
3-6	94	69	55	330	210	200
6-9	60	30	35	280	200	200
9-12	15	15	15	200	200	200

However, most results have shown that the reduced phosphorus distribution has not hurt corn grain yield or phosphorus uptake (Tables 8 and 9). This may be due to the concentration of roots in the same zone as the fertilizer under conservation tillage systems (Table 10). In addition, the conservation of moisture associated with conservation tillage allows the roots to remain active in the upper soil zones during times when it might otherwise have been too dry under conventional tillage for good root activity.

Table 8. Effect of fertilizer placement on corn yield.

		P_2O_5 (pounds per acre)		
Tillage	Fertilizer Placement	0	60	120
		(Yield, bushels per acre)		
Moldboard Plow	Broadcast	97	130	120
Chisel Plow	Broadcast	91	125	130
Chisel Plow	Injected--8 inches	--	125	129
Chisel Plow	Band	--	125	127

Table 9. Effect of tillage on phosphorus concentration in small plants.

Tillage	Phosphorus Concentration %
Moldboard Plow	.41
Chisel Plow	.40
No-Tillage	.41

Table 10. Influence of tillage on corn root weight.

	Root Weight (milligrams per core)		
Depth (inches)	Plow	Chisel	No-Till
0-3	250	275	625
3-6	325	325	250
6-9	170	160	160
9-12	75	70	75

On the other hand, a number of researchers have reported a decrease in potassium uptake associated with conservation tillage. In work at Indiana, the decrease was significant in the abnormally dry year of 1980, but there was no difference in 1981 when moisture supplies were adequate (Table 11). Wisconsin researchers also have shown decreased potassium concentrations with conservation tillage. They have attributed this effect in part to increased compaction and, therefore, decreased aeration under conservation tillage.

Table 11. Effect of tillage systems on potassium concentration in corn at silking.

	Potassium Concentration %	
Tillage	1980	1981
Moldboard Plow	1.77	2.27
Chisel Plow	1.56	2.21
No-Till	1.49	2.27

Because of the cooler, wetter soil conditions created at planting time by conservation tillage systems, some researchers have observed a benefit from the use of starter fertilizer. In certain situations, this has occurred even though soil test levels were reasonably high.

Soil Acidity And Liming

Nitrogen fertilizers increase soil acidity, which means that they lower the pH. Therefore, the rate and distribution of pH changes in the soil will depend on nitrogen placement

and nitrogen rates, as well as soil type and tillage. In an Indiana study, nitrogen was applied to the soil surface on conventional and zero-tillage corn for six years. The results (Table 12) show that although the total soil acidity changes were about the same in the "plow layers" of both soils, there was an unusually great pH decrease in the top 2 inches of the zero-tillage plots.

Table 12. Effect of tillage on soil pH with surface-applied N. (Griffith, 1974)

	Depth (inches)				
Tillage	0-1	1-2	2-3	3-6	0-6
			Soil pH		
Zero-tillage	5.2	5.4	6.0	6.5	6.0
Conventional	---	---	---	---	6.0
Initial pH					6.5

The activity of triazine herbicides, such as atrazine, Sencor and Lexone, is decreased in acid soil. Consequently, where nitrogen has been topdressed for several years with shallow or no-tillage systems, it is possible that a low pH zone in the top 1 to 3 inches of soil could reduce the effectiveness of triazine herbicides and reduce weed control.

A thin zone of acid soil near the surface will not be detected when soil samples are taken from the 6- to 8-inch "plow layer". That's why separate soil samples from the top 2 inches of soil should be taken at the same time that plow layer samples are obtained for a regular soil test. A quick test for soil pH on the shallow samples will determine whether an acid zone is present at the soil surface.

Limestone recommendations for most soil-testing laboratories are based on the assumption that moldboard plowing to a depth of 9 inches will be used to thoroughly incorporate limestone into the plow layer. Where plowing is less than that depth or the tillage system used will not incorporate to the full depth of tillage, the limestone rate should be reduced proportionately. Failure to adjust the limestone rate may result in an over-liming of the soil in the zone where the limestone is concentrated. At very high pH levels, triazine herbicide activity is increased and the risk of crop injury by these herbicides may also be increased.

Summary

Although changes in the tillage practices do create differences in fertility distribution and reactions, none of these changes create insurmountable problems. As long as these differences are recognized and proper management techniques are used to compensate, fertility will not be a major factor influencing yield irrespective of the tillage system used.

Here are some suggested practices to follow for fertility management with conservation tillage systems:

1. Prior to starting a conservation tillage program, build the soil phosphorus, potassium, and lime levels to suggested goals throughout the upper 9 inches.

2. Consider using a starter fertilizer at planting time. This is especially true for no-till where the soil remains cooler and wetter.

3. Monitor soil test levels every four years. Include in the sampling program a few samples at varying depths to monitor nutrient distribution.

4. If nutrient distribution, including pH, becomes a problem, periodically include a tillage practice that will thoroughly mix the upper 6 to 8 inches of soil.

5. Use an injected nitrogen source if possible. If that is not possible, dribble the nitrogen on the surface at 30-inch spacings.

6. If the nitrogen must be broadcast on the soil surface without incorporation, do it when the probability of receiving rain in the next few days is high.

7. If nitrogen is applied in fall or early spring, consider using a nitrification inhibitor.

Weed Control for Conservation Tillage

By Ellery L. Knake
Extension Weed Specialist
University of Illinois
(Presented at all three regional conferences.)

Development of new equipment for tillage and planting and an ever-increasing arsenal of herbicides now make conservation tillage more practical than ever. There has been a significant trend from moldboard plowing to chisel plowing, and interest in no-till is growing every year. Planters now available are suitable for planting in nearly any reasonable type of crop residue, including no-till situations. Options are numerous and varied, and an individual can select nearly any tillage program he believes to be best adapted to his soils, topography, and cropping system.

The next step is to design a weed-control program that best fits the tillage system selected. The herbicide arsenal provides enough variety so that herbicides can be selected to fit nearly any tillage system with a high degree of success. A consideration in doing this, however, is the preceding crop and the type of crop residue or vegetation to be encountered.

Corn After Soybeans

One of the easiest places to reduce tillage is when planting corn after soybeans. Research and farmer experience has generally shown little or no advantage for plowing soybean stubble. If nearly all Illinois farmers would simply leave their soybean stubble over winter, this would be a giant step forward for conservation tillage. Many farmers are already doing so.

With only modest crop residue from the previous year's soybeans and the soil generally in good physical condition, there are several weed control options. If a preplant incorporated treatment is desired, choices include Sutan+, Lasso, or Dual alone or in combination with atrazine and/or Bladex. The herbicides can simply be applied directly to the soybean stubble, preferably just ahead of a disk, field cultivator, or similar equipment. A second pass usually is desirable to provide more uniform distribution of the herbicide and thus better weed control. On sloping land, a residue cover of at least 30 percent may be necessary to significantly reduce erosion. Therefore, on such fields, greater emphasis can be placed on surface applications and postemergence treatments.

If surface application of herbicides such as Lasso, Dual, atrazine, or Bladex are preferred, at least one light

tillage operation can help to destroy existing vegetation and also help to open the soil for entry of the herbicide. But if this is too much tillage and it is more desirable to keep the soil covered with residue until the crop canopy is established, consider no-till planting. For no-till, herbicides such as paraquat or Roundup can be used to control existing vegetation, while preemergence herbicides provide residual control. However, remember that atrazine and Bladex can provide postemergence effect on small weeds, as well as residual control. Also, Banvel or 2,4-D can be used to replace or to complement earlier herbicides for broadleaf weed control.

If soybeans are to follow soybeans, a similar program can be followed with soybean herbicides. Paraquat or Roundup may be used to control existing vegetation, while residual control is offered with preemergence herbicides. The arsenal of postemergence herbicides for soybeans is larger than for corn.

Corn After Corn

For continuous corn with moldboard plowing or chiseling followed by secondary tillage, either preplant or preemergence treatments may be used, and postemergence herbicides can be considered, particularly for broadleaf weeds.

If no-till is used with continuous corn, fall panicum frequently increases. Research suggests that a little tillage can help to improve control of fall panicum with soil-applied herbicides. But if you prefer no tillage at all, soil applications of Lasso, Dual, Bladex, and Princep would be major considerations to control panicum. Bladex early postemergence also can be quite helpful; and Treflan or Prowl applied postemergence to the corn but preemergence to panicum can help to extend control.

Soybeans After Corn

Farmers have practiced crop rotations for many years, and more recently, they have used herbicide rotations. Today, another consideration is tillage rotations, in which less tillage is done following soybeans and a little more tillage is done in cornstalk residue prior to planting soybeans. In some research with soybeans following corn, yield results from moldboard plowing and from chisel plowing have been quite similar. However, planting soybeans no-till after corn has presented a significant challenge on some fields.

If soybeans are to be planted no-till after corn, paraquat or Roundup may be needed to control existing vegetation, although Lorox can have some postemergence as well as preemergence effect. No-till precludes preplant incorporated herbicides and rates of preemergence herbicides may need to be increased.

An increasing number of postemergence herbicides are now available for control of both grass and broadleaf weeds. However, total reliance on postemergence herbicides might be questioned. For example, Basagran is quite weak on pigweed and lambsquarters. Some of the soil-applied herbicides intended primarily for grass control can control pigweed and lambsquarters; but these two weeds might proliferate if reliance is entirely on postemergence herbicides. Thus, rather than switching entirely to postemergence treatments, there may be advantages for at least some soil-applied treatments supplemented with postemergence treatments. In making such decisions, the weed spectrum should be considered and closely monitored.

Volunteer corn also can be a problem in soybeans after corn, but fortunately several good controls are available. The dinitroanilines (Treflan and Prowl) are helpful, and Roundup, Hoelon, Poast, and Fusilade have been quite effective.

No-till Corn in Grass Sod

The time to start considering control of sod is at the time of seeding the small-seeded grasses or legumes. Try to select those species that will be the easiest and most economical to control in the future.

If the sod is primarily a shallow-rooted perennial grass such as tall fescue, paraquat plus atrazine may be satisfactory. However, grass species vary in their susceptibility. Atrazine alone may be adequate for bluegrass, which is very sensitive to atrazine, while some grass species are relatively tolerant of atrazine. Timothy appears to be relatively easy to control, and bromegrass is generally easier to kill than orchardgrass. An adequate rate of Roundup, properly timed, may sometimes seem a little expensive but can control perennial grass.

No-till Corn in Legume Sod

A stand of alfalfa or clover with no grass can be one of the easiest and cheapest to kill prior to planting corn. However, paraquat is not a good choice in doing this. While paraquat is satisfactory for some situations, it is primarily a contact killer and does not translocate to give good control of deep-rooted perennials like alfalfa. With paraquat, the tops may be burned, but plants soon regrow from roots much as if they had been mowed. Translocated herbicides will move into the roots, but not all of them work well on alfalfa. Roundup, for example, is a translocated herbicide, but control of alfalfa with it can be disappointing.

Translocated herbicides such as Banvel or 2,4-D, when used alone or in combination, can provide low-cost and effective control of alfalfa. It is preferable but not essential to treat in the fall while the plants are actively growing. This is when food reserves are being translocated

from the tops of the plants to the roots and herbicides can be moved more readily down into the roots. In the spring, alfalfa becomes more sensitive to 2,4-D as it approaches bloom stage. Sweet clover also is quite sensitive to 2,4-D, but it can be controlled with Banvel as well. Alfalfa and sweet clover have deep roots and are not generally controlled well with triazines alone.

Rates of 2,4-D and Banvel vary with the type of vegetation and growing conditions, but generally about 1 pound of 2,4-D acid equivalent per acre or 1/2-pound active ingredient (one pint) per acre of Banvel should be adequate. If 2,4-D and Banvel are used in combination, only half of these rates are necessary.

In some trials, one pint of 2,4-D (approximately 4 pounds acid equivalent per gallon) plus 1 pint of Banvel has done well. The combination can have an advantage if there are a variety of weeds present — some being more sensitive to 2,4-D and others more sensitive to Banvel. Also, if both grass and legumes are present, the use of Roundup plus 2,4-D or Banvel might be considered. While 2,4-D alone can give good control of sweet clover and alfalfa, it does not generally give good control of alsike, ladino, red, or mammoth clovers. A combination of atrazine and Bladex can give relatively good control of these shallow-rooted legumes prior to planting corn; but if touch-up control is needed, a pint of Banvel early postemergence for corn can usually complete the job. In addition to postemergence activity, the pint rate of Banvel can give some soil residual activity for preemergence control of annual weeds. If added strength is needed for annual grass weeds, consider applying Dual or Lasso preemergence.

Unfortunately, some herbicide labels have not quite "caught up" with recent research and may not be very specific about such uses. Stay within label guidelines and watch for possible label changes.

No-till Soybeans in Sod

Unlike herbicides used for corn in sod, the arsenal of herbicides for soybeans in sod is more limited. For grass sod, Roundup or possibly paraquat would be major considerations. Roundup would have the advantage of controlling some broadleaf perennials as well as grass. In addition, some of the new postemergence herbicides, such as Poast and Fusilade, may have potential; but recent research suggests that relatively high rates would likely be needed.

For soybeans in clover sod, herbicide options also are currently quite limited. Roundup is a consideration, but results may be less than desired. For alfalfa, the use of 2,4-D in the fall or perhaps in the spring, may be a possibility if adequate label changes can be made. 2,4-D should not be applied for soybeans unless registered and labeled for this use. The risk of injury to soybeans from Banvel precludes much consideration of it.

Preemergence herbicides, such as Lorox, Sencor, and Lexone, may have some effect on existing vegetation as well as provide residual control; but used alone, they will not adequately control alfalfa and clover.

Double-Cropping Soybeans After Wheat

This is already a well-established practice in the major wheat-producing areas of southern Illinois. Generally, soybeans are no-till planted directly in the wheat stubble. A combination of herbicides to control existing vegetation and to provide residual control have generally been used; and some of the new postemergence herbicides have potential for increased use on broadleaf and grass weeds.

Research suggests some potential for applying herbicides in wheat before harvest. A herbicide such as Surflan with adequate residual would be needed.

Intercropping, with soybeans planted in wheat before harvest, has been relatively successful in research trials and may have potential for moving the double-crop concept further north.

Insect Management in Reduced Tillage and No-till Corn

By K.L. Steffey and D.E. Kuhlman
Extension Entomologists
University of Illinois
(Presented at all three regional conferences.)

Concern about insect problems should not prevent a farmer from adopting a conservation tillage program. Nevertheless, insect problems are likely to change when a corn grower shifts to a no-tillage system. For example, minor pests may become major pests in a no-till corn field.

This is not to imply that pest problems will always increase with a no-till corn system or that pest problems make it impossible to grow no-till corn. It only points out that any alteration in the environment may cause a change in pest problems.

Crop residue left on the soil surface by the use of no-till gives many pests an environment suitable for survival and development. Some pests that may become greater problems in no-till corn than in conventional or reduced-tillage corn are European corn borers, cutworms, armyworms, common stalk borers, hop vine borers, wireworms, seedcorn maggots, billbugs, slugs, and mice.

Certain tillage operations favor specific pests, while others tend to reduce pest problems. Table 1, which is based on the estimates of Extension entomologists at the University of Illinois, describes the effects of tillage practices on pest problems in corn. It is essential to understand the biology, behavior, and habitat requirements of each pest species before one can project the impact that no-tillage may have on the abundance or damage potential of a pest.

Soil Insects

The type of crop rotation used and the prevailing weather conditions largely determine whether an insect problem will occur, and if so, what kind it will be. To a lesser degree, tillage is also a factor. However, the magnitude and extent of soil insect problems in no-till corn have not yet been determined.

Soil insecticides will probably be necessary for no-till corn that follows corn grown in rootworm-infested areas, as well as for no-till corn that follows grass sod, legumes, or any crop in which grasses and broadleaf weeds were prevalent the preceding season. Consult Circular 899, Insect Pest Management Guide--Field and Forage Crops (available at your local Extension office), for suggestions on control. Then select a soil insecticide that will control the anticipated soil insect pest.

Table 1. Estimates of the Effect of Different Tillage Practices on Insect Populations in Corn

Pest	Spring plowing	Fall plowing	Reduced tillage	No-till	Effective chemical control possible
Seedcorn beetle	0	0	?	+	yes
Seedcorn maggot	0	0	?	+	yes
Wireworm	0	-	?	+(sod)	yes
White grub	0	-	?	+(sod)	?
Corn root aphid	-	-	?	+(sod)	?
Corn rootworm	?	?	?	?(corn)	yes
Black cutworm	?	?	+?	+	yes
Billbug	?	?	?	+(sod)	?
European corn borer	-	-	+	+	yes
True armyworm	-	-	-	+(sod)	yes
Common stalk borer	-	-	?	+	no
Slugs	-	-	-	+	no
Mice	-	-	-	+	?

(0) Has no effect on the pest.
(?) Effect on the pest is unknown.
(+) Increases the population or potential for damage by the pest.
(-) Reduces the population or potential for damage by the pest.

Checklist for Soil Insect Control in No-Till Corn

1. Corn after soybeans. The potential for soil insect problems is low. A planter-box seed treatment will protect against attack by seedcorn beetles, seedcorn maggots, and wireworms. Scout fields for cutworm infestations.

2. Corn after corn. The potential for rootworm damage is moderate to high whenever corn follows corn in Illinois. Use a rootworm soil insecticide at planting.

3. Corn after grass sod. Cutworms, wireworms, and white grubs are potential problems. Apply a soil insecticide that is registered for these pests. Armyworms may also be a problem. Scout fields for cutworm and armyworm damage and be prepared to apply a postemergence treatment.

4. Corn after legumes. Grape colaspis, cutworms, white grubs, and wireworms are potential problems. Apply a soil insecticide at planting and scout fields for damage. Rescue treatments are reasonably effective against cutworms but not against other soil pests.

5. Corn after small grain. There is some potential for damage by wireworms. A soil insecticide at planting will usually be profitable.

Effect of Tillage on Application of Soil Insecticides

We originally believed that surface residues in no-till systems would present some problems with the placement and incorporation of granular soil insecticides applied at planting. However, recent research indicates that crop residue does not seem to reduce the effectiveness of soil insecticides applied in no-till or reduced tillage systems. NOTE: Before using Mocap, Dyfonate, Thimet, or Broot on no-till corn, be sure the soil moisture level is low enough to ensure that the seed furrow is closed; that way, the insecticide granules will not fall into the seed furrow and contact the seed. These products may injure crops.

Granular insecticides can usually be incorporated to some extent with a drag chain or tines. This may help prevent excessive breakdown of the insecticide by sunlight.

Corn Rootworms

Corn rootworms are the primary soil insect pest of corn in Illinois. Damage is almost exclusively confined to fields where corn is planted after corn. Research on the effect of tillage has produced highly variable results, but rootworm damage is not expected to be greater with a no-till system in continuous corn. In general, the only uniformly reliable method of controlling corn rootworms is using a crop rotation or a soil insecticide.

Rootworm control in no-till corn will remain consistent with the current practices and insecticide rates used for conventionally tilled corn.

Black Cutworm

No reliable means are currently available for predicting outbreaks of this pest, despite its annual appearance. Cutworm outbreaks in corn, however, tend to appear more frequently in reduced or no-tillage fields than in conventionally tilled (plowed) fields, probably because cutworm moths show a preference for depositing eggs on vegetation or surface debris.

Recent research and field observations indicate that several winter annual weeds, not buried by tillage, serve as egg-laying sites for black cutworm moths and food for larval survival. In the spring, winter annuals are usually absent or occur in smaller numbers in fields that have been fall-tilled. Weediness before planting contributes heavily to black cutworm problems. Fields that are tilled and planted late are more likely to develop a preplant weed infestation than fields that are planted early.

Other cutworm species can be important, depending on the previous crop. In recent years, damage by the dingy and claybacked cutworms has been more prevalent. Most problems with the dingy and claybacked cutworms have been in no-till

corn planted after sod or forage legumes. Moths of these two species lay their eggs in late summer or fall; then they overwinter as larvae and attack newly emerging corn seedlings the following spring.

For control of cutworms in no-till corn, apply a band application of Lorsban, Mocap, Dyfonate, Counter, or Furadan at planting. Read the labels carefully because phrases such as "suppression" or "will control light to moderate infestations" indicate that control may not be satisfactory when cutworms are numerous. Scout fields and apply a rescue treatment if needed.

Aboveground Corn Insects

Some aboveground insects are likely to be more of a problem in no-till than in reduced or conventionally tilled corn. We have observed significant damage by common stalk borer, European corn borer, true armyworm, corn flea beetles, and billbugs in no-till corn. In general, outbreaks of these foliage-feeding pests can be controlled with properly timed insecticide treatments; but close monitoring of fields to detect insect outbreaks is vital.

Common Stalk Borer

Damage by this insect is generally confined to corn rows that are adjacent to fence rows, ditch banks, and grass waterways. The standard practices of plowing and disking apparently destroy the eggs deposited during the preceding August and reduce the potential for damage. However, in some no-till corn fields and in a few fields where reduced tillage is used, we have seen serious infestations of common stalk borers throughout the field.

Damage is usually associated with a weed infestation in the preceding crop. Moths of the common stalk borer deposit their eggs on ragweed, dock, pigweed, and other broadleaf weeds and grasses in late August and September. When fields infested with these weeds are planted using a no-till system, herbicides kill the existing vegetation and the food supply becomes unacceptable for the newly hatched stalk borer larvae. Consequently, the newly hatched stalk borers attack the emerging corn plants, causing serious damage.

Research concerning the timing and placement of rescue treatments may help in our efforts to control stalk borers. Current research indicates that a "rescue" insecticide applied three to five days after burndown with paraquat or 10 days after burndown by Roundup should control the borers as they move from dead weeds to corn.

True Armyworm

No-till corn planted in rye, bluegrass, or fescue pastures in Illinois has frequently been damaged by armyworms. Moths of the armyworm lay their eggs in stands of

rank grass during April and May. After herbicides are used to kill the vegetation, newly hatched armyworm larvae move to the seedling corn plants to feed, often causing severe damage. Control is justified when 25 percent of the plants are being damaged. Rescue sprays are effective if the infestation is spotted early.

A spray volume of 10 to 20 gallons per acre will improve coverage and control. Monitor fields closely for damage as soon as the corn plants emerge.

European Corn Borer

This insect overwinters in corn stalk residues. Therefore, any change in tillage practice that leaves a greater amount of residue on the soil surface will favor survival of overwintering borers and could result in an increased future infestation. Fortunately, several insecticides, when applied as foliar treatments, will give effective control of first- and second-generation corn borers. Although no-till corn may increase the potential for European corn borer outbreaks, other important regulatory factors, such as disease and weather conditions during moth emergence, can reduce corn borer populations to levels that are not economically damaging.

Summary

We do not regard insect pests as an insurmountable obstacle to reduced tillage or no-till corn production, and we do not feel that concern about insects should keep growers from attempting or adopting a no-till corn system. Although insect pests are not likely to limit the implementation of no-till corn in Illinois, only the most careful management will eliminate any insect problems that develop.

The soil insect complex in no-till corn can be controlled by applying the appropriate soil insecticide at planting time. Outbreaks of aboveground pests, with a few exceptions such as the common stalk borer and hop vine borer, can be controlled with properly timed treatments of insecticides. The most critical factor contributing to successful no-till corn production is careful monitoring of fields to detect insect outbreaks.

Regular field observations should help growers avoid problems and identify insects that should be treated promptly.

The following points summarize the impact of insect problems and control in no-till corn:

1. Scouting fields will become more important in detecting pest outbreaks.

2. In some instances, no-till corn will favor outbreaks of certain insect pests not ordinarily observed in conventional tillage systems.

3. A continued, and possibly greater, reliance on insecticides will be necessary.

Why Zero-Tillage?

By G.E. McKibben
University of Illinois Agronomist, Retired
(Presented at the southern regional conference.)

It should be a continuing goal of the farmer, the industry, the agricultural experiment stations, and the general citizenry to devise and adopt into general practice a system of farming that will restore, increase and permanently maintain the productive power of American farmlands. Zero-tillage is considered to be one such system.

Zero-tillage, the planting of crops without tillage into live sods or residues from previous crops, has been described as the single most effective conservation technique developed for the reduction of erosion and sedimentation from farmlands.

The research needed to study the zero-tillage system of crop production in Illinois was begun at the Dixon Springs Agricultural Center in 1962. It has involved the planting of crops, without seedbed preparation, into live sods or residues from previous crops.

Zero-tillage embodies what Andrew Sloan Draper (University of Illinois president, 1984-1904) had in mind when he said, "The wealth of Illinois is in her soil, and her strength lies in its intelligent development"; and it embodies what Cyril G. Hopkins (head of the U of I Department of Agronomy, 1900-1919) had in mind when he said, "The coal mine yields a single harvest -- one crop -- and is then forever abandoned; while the soil must yield...a thousand crops, and even then it must be richer and more productive than at the beginning, if those who come after us are to continue to multiply and replenish the earth."

For zero-tillage to be an acceptable agronomic practice to those who own or farm the land, it was necessary to develop techniques that provided yields comparable to those of a conventional seedbed at comparable costs. In other words, there needed to be an answer to the question, "Why is zero-tillage a desirable practice?"

Because tillage destroys organic matter, zero-tillage effectively <u>preserves</u> organic matter. And a soil high in organic matter has better water-holding capacity and better tilth than a soil low in organic matter. In turn, soil with greater tilth provides a favorable environment for the development of the root system. Organic matter also is a source of nutrients.

Although it has been recognized for several years that the potential existed to produce crops without tillage, the concept of zero-tillage had to await the development of herbicides to control undesirable vegetation at planting, as well as any that might develop during crop production.

One of the early herbicides that showed promise in controlling grass sods was Aatrex, which was usually applied at double the rate for conventional seedbeds. But it was not until paraquat (a contact herbicide) plus surfactant became available that residual herbicides such as Aatrex, Princep, and Lasso became effective in zero-tillage corn production; and Surflan, Sencor, Lexone, and Lorox became effective in zero-tillage soybean production.

The addition of Roundup, a translocatable herbicide, provided for control of certain plant species, such as established fall panicum, foxtail, and smartweed -- species that paraquat did not adequately control.

But herbicide selection was only one of the areas requiring study in the development of the zero-tillage concept. The following areas also required study:

1. Cultural practices (time of planting, plant population, row spacing).

2. Insect control.

3. Equipment (planters that adjust to residues).

4. Spraying equipment to apply herbicides as liquid or powder -- both preemergence and postemergence.

5. Nitrogen applicators that will apply N preplant or side-dress in residue.

6. Rodenticides, preferably repellents.

Success with zero-tillage demands attention to the same problems that confront conventional tillage, but it has some additional problems. Keep in mind these qualities of no-till:

1. The planting date can be later than with conventional tillage.

2. Systemic insecticides may be desirable.

3. Planting equipment that can operate in residues and give precise depth control are needed; insecticide and fertilizer boxes may be desirable.

4. Spraying equipment adequate for preemergence, postemergence and over-the-top application of herbicides are important. Also, more gallons of water may be required to wet the vegetation in zero-tillage when paraquat is applied on large plants. Be sure the pump is adequate.

5. Equipment for directed sprays may be desirable.

6. Nitrogen applicators for anhydrous ammonia need a coulter in front of the knives to cut through trash. To reduce nitrogen loss, a squeeze pump may be needed for the application of urea solutions through applicator knives.

7. Additional herbicides or herbicide combinations may be desirable.

8. Minor-use herbicides would be desirable, but the expense of clearing such herbicides might not be economical.

9. Certain weed problems may increase in zero-tillage.

10. Rodents may be a problem in zero-till corn.

11. A starter or pop-up fertilizer for corn may be desirable in zero-tillage because the mulch reduces soil temperature and keeps the soil more moist.

12. Surface application of potash and superphosphate have provided satisfactory yields over a 20-year period; however, potash soil-test values are lower than expected. (Apparently, a significant amount of potash is lost in the runoff water.)

During the next century, the techniques for zero-tillage will continue to be a cooperative development by the experiment stations, the industry, the landowners, and the tillers. Hopefully, these techniques will allow for maximum production with maximum protection of those Illinois soils subject to excessive erosion. New herbicides will further enhance weed control, and new equipment will make spraying more effective. Less water will be required to dispense herbicides, and calibration of equipment will be even more critical. Planting equipment, which is almost adequate now, will be further improved.

Central Illinois Ridge Tillage Farmer Panel

Leefers Farm, Art Leefers and son
Carlinville, Illinois

Acreage--600 acres ridge planted in 1984 and 1,500 acres planned for 1985.
Number of years used--First year was 1984.
Rotation--Corn/soybean.
Tillage procedures--Dual and Sencor banded preemergence on soybeans, and Bicep on corn. Ridges were built in 1983 and soybeans planted in 1984.
Special equipment or modifications--Ridges were begun using a conventional cultivator with modified shovels. Planting was done using a Hiniker tillage unit with an International 800 planter. Currently using a Buffalo Till cultivator.
Reasons for choosing this system--(1) To reduce tillage, herbicide, and other production costs; (2) to improve row drainage on poorly drained soils.
Soil types--Herrick, Harrison, and Virden.
Problems--Getting the necessary know-how to get started.

Jack and Jim Brown Farm
Beason, Illinois

Acreage--800 acres ridge planted.
Number of years used--Four years.
Rotation--Corn and soybeans.
Tillage Procedures--Bladex, atrazine, and 2,4-D applied on corn. Amiben banded on beans with spot spraying of Basagran and Poast.
Special equipment or modifications--12-row mounted planter with ridge-clearing attachments. We use a Buffalo cultivator.
Success rating--Very successful.
Reasons for choosing this system--Eliminates trips over the field, thus reducing compaction and costs.
Soil type--Silt loam.
Problems--Keeping planter on ridges with pull-type planter. We corrected this with stabilizer and rowfinder. We have a mounted 12-row folding planter that we like better than the pull-type.

J. Roger Cooper and Tom Foran Farm
Williamsville, Illinois

Acreage--200 acres of corn ridge planted in 1984, and 750 acres to be planted in 1985.
Number of years used--One year with corn only.
Rotation--Corn/soybeans.
Tillage procedures--In corn, we combat grasses with Lasso (liquid) in 15-inch band at planting with 15-gallon-per-acre broadcast rate; we combat broadleaves with 1/2-pint of 2,4-D Ester plus 1/2-pint of Banvel at 10-gallons-per-acre broadcast rate at the five-leaf stage. No insecticides are used. For

fertility, we broadcast dry material over the top by truck in February when the ground is clear of snow but frozen. We spring-apply anhydrous ammonia before, after and even during planting. Applicator has 30-inch centers (middles) and a regular tool bar with coulters.
Special equipment or modifications--(1) Our RG830 rear cultivator is modified with wings. (2) We use a Hiniker eight 30-inch row ridging cultivator with tunnel fenders and anhydrous hitch. (3) We added Hiniker horizontal disk ridging units to a John Deere 7100 eight 30-inch row planter.

Neil E. Pistorius Farm
Blue Mound, Illinois

Acreage--700 acres ridge planted.
Number of years used--We're ending our third year.
Tillage procedures--Apply dry fertilizer and anhydrous ammonia in the fall. Plant and then band herbicide and insecticide. Spot-treat with postemergence herbicides, cultivate, and harvest.
Special equipment or modifications--We use a Buffalo cultivator, as well as a Buffalo ridge runner till-plant attachment on our 7000 John Deere planter.
Success rating--Not much different from previous systems used.
Reasons for choosing this system--To conserve soil and save on fuel and equipment costs.
Soil types--Drummer, Flanagan.

Central Illinois No-till Farmer Panel

John A. Beatty Farm
Waverly, Illinois

Acreage--650 acres of no-till corn.
Number of years used--This was my second year.
Rotation--No-till corn after beans.
Tillage procedures--We do no fall tillage on the bean stubble, and we spread dry fertilizer in either the fall or spring. Lorsban is put down in a 7-inch band with the corn planter. Immediately after planting, grass herbicide is sprayed on, using 25 to 40 gallons per acre as a carrier. We usually use 20 gallons of water and 20 gallons of 28 percent nitrogen. When the corn spikes through, Banvel is applied.
Special equipment or modifications--Bigger combine chopper spreader and rolling coulters on the front of each row of the planter.
Success rating--Very successful.
Reasons for choosing this system--Less labor, less machinery, and less fuel.
Problems--None.

Charles W. Guthrie Farm
Johnson Township, Christian County, Illinois

Acreage--420 acres, all farmed under conservation tillage. All corn and 50 percent of the beans were no-tilled in 1984.
Number of years used--Started conservation tillage in 1967. We have been using no-till for four years.
Rotation--Corn-corn-soybeans.
Tillage procedures--We spray Aatrex and/or Bladex and Lasso in 20-gallon 28-percent nitrogen solution behind the planter in one pass. We apply Furadan on second-year corn and band Lorsban over the row if cutworms are a problem. Banvel is applied where needed. In the fall, we apply 200 pounds of 18-46-0 and 200 to 300 pounds of 0-0-60. We side-dress 120 to 150 pounds of Kaiser 3N. in 1984, we used some starter.
Special equipment or modifications--John Deere 7000 planter with no-till coulters; starter fertilizer pumped in the row with 12-volt pump; 3-point hitch mounted tank used for herbicide.
Success rating--Very successful in corn. Have had some weed problems in soybeans, and stands can be variable.
Reasons for using this system--To reduce soil erosion, save on labor, reduce trips and reduce compaction. Also, we need less machinery and horsepower.
Soil types--Just about every kind.
Problems--The slot for seed is not closing in some soils, so I purchased the cast iron closing wheels. This is a must for planting in sod and helpful in harder soils.

Dennis Barnard Farm
Blue Mound, Illinois

Acreage--80 acres in conservation tillage.
Number of years used--Four years.
Tillage procedures--Corn: no-till into PIK ground. Applied 45-115-169 dry blend on top of the ground. Sprayed 1 quart of Banvel broadcast preplant. Used Dyfonate insecticide at planting, then a preemergence application of Bronco. Side-dressed 175 pounds of nitrogen.

Soybeans: Planted in previous bean stubble no-till. Applied 1 pint of 2,4-D preplant. Dry blend of 0-44-60 spread on top. Poast and Basagran used postemergence in two separate applications.
Success rating--Yields just as good as conservation tillage with the Soil Saver.
Reasons for choosing this system--To stop erosion.
Soil type--Miami.
Problems--No insurmountable problems.

Southern Illinois Farmers Speaking on Tillage

Gary C. Miller Farm
Marshall, Illinois

Acreage--425 acres.
Number of years used--Three years ridge planted.
Rotation--Corn/soybean, 20-40 acres of wheat.
Tillage procedures--Fertilizers broadcast and chemicals broadcast over the top. Liquid 28 percent nitrogen applied at cultivation.
Special equipment or modifications--5-row planter, cultivator, and corn head.
Success rating--Haven't used it long enough to judge.
Reasons for choosing this system--To build up soil aggregation, limit use of chemicals, control soil erosion, and save money on equipment.
Soil types--Stoy and Weir.
Problems--(1) Soil hardness, (2) weed control, and (3) fertilizer placement.

Gene Russell Farm
Richview, Illinois

Acreage--1,300 acres in no-till.
Number of years used--15 years.
Rotation--Corn or milo-beans-wheat.
Tillage procedures--Normal spray application is made at planting; then postemergence spraying is done where needed with Basagran and Poast in beans. Aatrex and oil is used in corn and milo.
Special equipment or modifications--Offset disk, chisel plow, Tye no-till drill, no-till planters. I no longer own a moldboard plow.
Success rating--Pleased with results. Yields have increased.
Reasons for choosing this system--To stop some of the erosion.
Soil types--Varies according to areas (Ava, Bluford, Wynoose) (Hoyledon, Cisne, Huey).
Problems--Some weed problems.

Kenneth R. Kamper, G-K Farms
Freeburg, Illinois

Acreage--In 1984, I planted 350 acres of no-till corn and beans, and I chisel plowed 400 acres.
Number of years used--No-till corn for 11 years and no-till full-season soybeans for seven years. No ground plowed since 1976.
Rotation--Corn-soybeans-wheat (double-cropped to beans).
Tillage procedures--No-till is rotated with chisel plowing. Corn fields are soil tested and fertilizer is applied according to soil test. In soybean fields, fertilizer is applied where there are fertility problems. Wheat fertilizer is applied according to the expected yield plus double-crop needs. Anhydrous is used on both chisel and no-till corn.

Herbicide program for corn:

Chisel--Preplant incorporated with field cultivator. 1 1/4 pounds of Aatrex 90 per acre and 2 1/4 quarts of Bladex 4L.

No-till--Sprayed on after planting. 1 1/2 pounds of Aatrex 90 per acre, 2 1/4 quarts of Bladex 4L, 1 quart of paraquat, and 1 pint of 2,4-D LJ4.

Herbicide program for soybeans:

Chisel--Preplant incorporated. 1 quart of Treflan per acre, 1/2 pound of Lexone DF.

No-till--1/2 pint of 2,4-D per acre two weeks before planting. 1 quart of Surflan L per acre, 2/3 pound of Lexone DF, 1 quart of paraquat, and an additional 1/2 pint of 2,4-D (if needed).

Special equipment or modifications--Three no-till planters, all Allis Chalmers. Present planter is an AC 12-row converted to 22 rows for soybeans.

Success rating--It has reduced soil erosion and increased yields.

Reasons for choosing this system--To reduce erosion and increase yields.

Soil types--Iva, Herrick, Alford, Fayette, Virden, Wakeland.

Problems--Similar problems as with conventional tillage--cutworms and weed control. We have different problems in different years.